



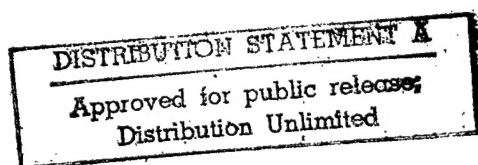
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# ***JPRS Report***

# **Science & Technology**

***Central Eurasia:  
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# Science & Technology

## CENTRAL EURASIA: Chemistry

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### The Formation of Finely Dispersed Aerosol in the Temperature Cycle

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[Abstract] The atmospheric physics literature contains a great many publications regarding the formation, transfer, and evolution of atmospheric aerosol. After briefly reviewing the major ideas that have been advanced regarding the formation of aerosols in the atmosphere, the authors of the study reported herein hypothesize that a process in which air is cooled to a certain temperature and then reheated either to that same initial temperature or to a higher temperature may be one possible way of generating and transforming a highly dispersed aerosol in the atmosphere. They designed and constructed an experimental unit to test this hypothesis. They conducted their experiments in winter and summer at the Novosibirsk Akademgorodok [academy test station]. Air samples were taken by an air sampler located on the roof of the institute building. An aspiration space velocity of 1 l/min was used. Samples were taken 4 to 5 meters above the roof peak so as to avoid sampling any air from the institute's buildings. The air sampler and experimental unit were connected to one another by a 15-foot hose. The air was cleansed of aerosol particles by AFA-KhA filters, after which it was passed through three heat exchangers to cool it and then heat it to specified temperatures controlled by thermocouples. The time for which the air was passed through

the heat exchangers was kept constant at 1.5 to 2 s. The process of cooling air samples and subsequent reheating them to their initial temperature resulted in the formation of a highly dispersed aerosol with a concentration on the order of  $10^4 \text{ cm}^{-3}$ . The disperse makeup and concentration of the resultant aerosol were determined by using a C grid-type diffusion battery, condensation consolidator, and photoelectric counter. Another series of tests was conducted. In those tests a single cooler was used to cool the air, after which it was reheated to a temperature higher than its initial temperature. The particles formed were about 10 nm in size and were found to manifest a rather high heat resistance that eliminated the possibility that they are formed in accordance with a condensation mechanism. The concentration of the highly dispersed aerosol did not change even when heated all the way up to  $50^\circ\text{C}$ . Moreover, heating to  $350^\circ\text{C}$  did not result in the anticipated disappearance of the particles (their concentration did decrease to about half, however). This finding was taken as indicating a significant variation in the heat resistance of the particles formed that was in turn evidently due to differences in their chemical makeup. Yet another series of tests was performed. Two coolers were used. The humidity was not measured in the tests performed, but qualitative conclusions regarding its effect were drawn. Adding a humidifier to the test circuit did not change the threshold temperature of aerosol particle formation ( $-35^\circ\text{C}$ ). The authors deemed their tests a success in that they did succeed in forming a highly dispersed aerosol with the aforesaid concentration. Problems with the experimental unit prevented them from analyzing the properties of the particles formed and thus made it impossible for the authors to reach any conclusions about the aerosol's chemical makeup or formation mechanism. Figures 3; references 13: 3 Russian, 10 Western.

**Acidity and Catalytic Properties of Modified Type ZSM-5 Zeolites During Aromatization of Propane**

927M0048D Moscow NEFTEKHIMIYA in Russian  
Vol 31, No 4, Jul-Aug 91 pp 475-481

[Article by B. L. Vorobyev, Yu. N. Koshelev, Ye. P. Khvorova, A. A. Kharchenko, O. M. Oranskaya, S. M. Zveryev, and K. M. Mukhenberg]

UDC66.097.3:661.183.6

[Abstract] Modification of type ZSM-5 zeolites with gallium increases their catalytic activity and selectivity in the formation of aromatic hydrocarbons during conversion of lower alkanes. The published data on the nature, structure, and localization of active sites in Ga-containing zeolite catalysts, as well as the concepts on the mechanism of the effects on the catalytic conversion of the lower alkanes, are contradictory and are in need of further clarification. In the present work a study was made of the catalytic properties of the above modified zeolites in the aromatization of propane and their acidic properties. It was demonstrated that both of these properties of gallium-containing high silica catalysts, as prepared by modification the ammonia form of silica alumina, are unaffected by the method of promoter introduction, although their initial characteristics and treatment times may differ. It was also demonstrated that modification of the ammonia form of a silica alumina catalyst with gallium results in both higher dispersion of the modifier and in interaction with the zeolite surface leading to a change in its acidic and catalytic properties. Figures 3; references 8: 7 Russian, 1 Western.

**Combined and Separate Hydrogenation of CO and Acetylene Over Catalysts Containing Group VIII Metals**

927M0048E Moscow NEFTEKHIMIYA in Russian  
Vol 31, No 4, Jul-Aug 91 (manuscript received  
25 Jul 90) pp 482-488

[Article by Yu. I. Pyatnitskiy, S. N. Orlik, O. P. Nesterova, and G. G. Girushtin, Physical Chemistry Institute imeni L. V. Pisarzhevskiy, Kiev]

UDC541.128.13

[Abstract] In previously published work it was demonstrated that addition of acetylene to synthesis gas induces formation of oxygen-containing compounds at high pressures and over fused iron catalysts. Addition of acetylene over cobalt catalysts and at atmospheric pressure results in an increased yield of liquid hydrocarbons. In the present work a study was made of separate and combined hydrogenation of carbon monoxide and acetylene at atmospheric pressure over catalysts containing the group VIII metals Fe, Ni, Pd, and Rh. Hydrogenation in both modes in the presence of iron and nickel

catalysts results in formation of hydrocarbons conforming to Schultz-Flory distribution. Experimental data most nearly conform to a surface polymerization scheme. In contrast to iron and nickel catalysts, rhodium and palladium promote formation of oxygen-containing compounds as well as hydrocarbons. Figures 2; references 11: 9 Russian, 2 Western.

**Activity of Zeolite Catalysts for Alkylating Isobutane with Butenes**

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Vol 31, No 4, Jul-Aug 91 (manuscript received  
9 Sep 90) pp 490-498

[Article by V. I. Kashkovskiy, P. N. Galich, K. I. Patrilyak, and L. M. Royev, Bioorganic Chemistry and Petrochemistry Institute, Kiev]

UDC542.952.53:665.652.4:547.21

[Abstract] The activity and selectivity of zeolite catalysts, such as faujasite, in butene alkylation of isobutane, as well as in other carbonium type reactions, are largely determined by the nature, strength, and concentration of acid sites. However, the mechanism for the formation of an active site and its functions in the catalytic act remain unclear. Ion exchange cations play a significant role in the formation of acid sites in zeolite catalysts. The activity of these catalysts in alkylation reactions is also determined by the nature of the ion exchange cation. Thus, changing the composition of a catalyst may affect its acidity and therefore its catalytic activity. The sodium forms of type X and Y zeolites are known to be inactive in alkylation reactions, and the calcium form is only mildly active. Addition of lanthanum cations significantly improves the basic indicators of the process, the alkylate output being increased by a factor of four. In the present work a study was made of the nature of the activity of zeolite catalysts for butene alkylation of isobutane. A criterion for the efficiency of these catalysts has been demonstrated to be the interaction of the various type acid sites when they are in certain ratios with the active site. Equal intensity absorption bands in hydroxyl group valence fluctuation at 3550 and 3650  $\text{cm}^{-1}$  serves as a qualitative indicator. Acidity of the active site is enhanced with lanthanum cations. These have strong acceptor properties which facilitate high proton mobility owing to the induction effect. Catalyst deactivation occurs as a result of changes in the nature of the active site. Figures 5; references 17: 11 Russian, 6 Western.

**Conversion of 4-Methyl-4-hydroxytetrahydropyran Over Solid Acid Catalysts**

927M0048G Moscow NEFTEKHIMIYA in Russian  
Vol 31, No 4, Jul-Aug 91 (manuscript received  
9 Jan 91) pp 499-502

[Article by V. Z. Sharf, A. M. Mezheritskiy, V. I. Der-evtsov, V. N. Trofimov, and N. V. Ekkert, Organic

Chemistry Institute imeni N. D. Zelinskiy, Moscow;  
Chaykov Synthetic Rubber Plant]

UDC574.266;542.938;542.952.1

[Abstract] In the industrial process for the production of isoprene from isobutylene and formaldehyde, a considerable amount of high boiling point side products are also formed. Specifically, in the 4,4-dimethyl-1,3-dioxane synthesis stage, 8-10 percent 4-methyl-4-hydroxytetrahydropyran is formed as a side product which has no practical use. However, this product may serve as means for preparing the more useful 4-methyl-5,6-dihydropyran, isoprene, and formaldehyde. In the present work a study was made of the effects of the acid nature of the catalyst and the reaction conditions on the direction and extent of decomposition of the title compound. At 220° C carbinol inhibits dehydration with the formation of a mixture of 4-methyl-5,6-dihydropyran and 4-methylenetetrahydropyran. At higher temperatures the pyran ring splits resulting in the formation of isoprene and formaldehyde. By varying the reaction conditions, 4-methyl-4-hydroxytetrahydropyran may be converted at high yield into either methylhydropyran or isoprene and formaldehyde. Figure 1; references 3 (Russian).

#### Fe-Mn Catalysts for Hydrocarbon Synthesis from CO and H<sub>2</sub>

927M0048H Moscow NEFTEKHIMIYA in Russian  
Vol 31, No 4, Jul-Aug 91 (manuscript received  
10 Dec 90) pp 511-514

[Article by A. L. Lapidus, M. M. Savelyev, and M. V. Tsapkina, Organic Chemistry Institute imeni N. D. Zelinskiy]

UDC547.31.057

[Abstract] Iron-potassium-alumina catalysts manifest activity in the synthesis of aliphatic hydrocarbons from carbon monoxide and hydrogen, and are characterized as having high selectivity in respect to formation of low molecular weight olefins. It has also been demonstrated that introduction of Mn in the composition of Fe-on-alumina as prepared by precipitation increases the selectivity of these catalysts in respect to formation of low molecular weight olefins. On the other hand, it was also reported that promotion of Mn does not change the

selectivity of analogous catalysts. In the present work a study was made of the Fe-Mn-alumina catalyst system in the synthesis of hydrocarbons from CO and hydrogen at 380° C, 120 hourly space velocity, and 3:2 CO:H<sub>2</sub> ratio. Synthesis products consisted of C<sub>1</sub>-C<sub>6</sub> aliphatic hydrocarbons, C<sub>6</sub>-C<sub>8</sub> aromatic hydrocarbons, and carbon dioxide. It was demonstrated that changing the Mn:Fe ratio has no significant effect on the composition of the reaction products. The activity of the catalysts increased inversely with the Mn:Fe ratio almost six times. A catalyst containing only Mn was inactive. The distribution of hydrocarbon products by molecular weight makes it possible to conclude that the routes of aromatic and aliphatic hydrocarbon synthesis are different. Figure 1; references 5: 3 Russian, 2 Western.

#### Correlation of Rates of Main Reaction and Catalyst Poisoning Process as Function of Changes in Active Site Concentration on Catalyst Surface

927M0049C Moscow VESTNIK MOSKOVSKOGO  
UNIVERSITETA: SERIYA 2, KHIMIYA in Russian  
Vol 32, No 4, Jul-Aug 91 (manuscript received  
18 May 90) pp 350-354

[Article by Yu. I. Azimova and R. Ye. Mardaleyshvili, Chair of Chemical Kinetics]

UDC541.128.5

[Abstract] During the course of a catalytic process, the reaction medium itself affects the catalyst through caking, corrosion, changes in valency state, blockage of surface sites with catalytic poisons, etc. These in turn alter the quantity and/or the concentration of active sites. Changes have also been observed in catalyst selectivity while other conditions remained constant. Apparently, in these systems, the change in concentration of active sites resulting from the reaction medium becomes the variable parameter. One characteristic route in various catalytic processes is catalyst poisoning by reaction products still remaining adsorbed on the catalyst surface. In the present work experimental and published data are presented to demonstrate that in processes which include both the main reaction and catalyst poisoning, for catalyst poisoning to take place it is necessary that the number of active sites contiguous to the catalyst exceed or be equal to that of the main reaction. This is used as a basis for recommending steps to suppress poisoning by decreasing the number of catalytically active sites. Figures 2; references 36: 10 Russian, 26 Western.



**Electrocatalytic Oxidation of Certain Biologically "Rigid" Surfactants**

927M0049D Moscow VESTNIK MOSKOVSKOGO  
UNIVERSITETA: SERIYA 2, KHIMIYA in Russian  
Vol 32, No 4, Jul-Aug 91 (manuscript received  
16 Feb 90) pp 395-397

[Article by Ye. V. Danilova and G. A. Bogdanovskiy,  
Chair of General Chemistry]

UDC541.128.13

[Abstract] At the present time there are a number of methods to treat water for biologically "rigid" surfactants such as Nekal (sodium dibutyl-naphthalene sulfoxide) and Leykanol (sodium polymethylen-naphthalene sulfoxide). However, these methods are either inefficient or introduce yet more pollutants to the effluent. In the present work it was demonstrated that anode current and hydrogen peroxide can be used to breakdown biologically "rigid" surfactants containing an aromatic ring. The surfactants are electrocatalytically oxidized in the first treatment stage followed by microbiological treatment in a second stage. References 5 (Western).



**Structure and Physical Chemical Properties of Irradiated  $\alpha$ -Cellulose**

927M0050A Ivanovo IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: KHIMIYA I  
KHIMICHESKAYA TEKHNLOGIYA in Russian  
Vol 34, No 6, Jun 91 (manuscript received  
17 Sep 90) pp 82-84

[Article by G. G. Kuryshko, Ye. L. Matukhin, A. A. Grigorenko, and G. G. Garifzyanov, Kiev Technological Institute of Light Industry; Chemical Products SRI, Kazan]

UDC678.54.002:612.001.5

[Abstract] Ionizing radiation is one of the most promising methods for modifying cellulose to bring it up to useable standards. Since it has been established that irradiation affects the entire range of physical and mechanical properties of cellulose, it may be assumed that this is related to the rate and depth of structural change at the molecular and supra-molecular levels.  $\alpha$ -Cellulose serves an indicator of the suitability of a cellulose batch for further treatment by characterizing its degree of breakdown, and for this reason it becomes desirable to establish the relationship between structural changes and the physical mechanical properties of this cellulose component during irradiation. In the present work a study was made of the changes in crystallinity, crystallite size, dynamic viscosity, and degree of polymerization during  $\gamma$ -radiation of  $\alpha$ -cellulose at 10-100 kilo-gramroentgens. Certain regularities were observed in the changes in dynamic viscosity and degree of polymerization. X-ray analysis showed that the structure of  $\alpha$ -cellulose remains unchanged below a saturation dosage of 100 kGr. Figures 2; references 6 (Russian).

**Study of Possibility of Automating Process of Chemical Nickelizing with Dimethylamine Borane**

927M0050B Ivanovo IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: KHIMIYA I  
KHIMICHESKAYA TEKHNLOGIYA in Russian  
Vol 34, No 6, Jun 91 (manuscript received  
3 Jan 91) pp 85-88

[Article by A. M. Kosov and Yu. V. Prusov, Nizhegorodskiy Polytechnical Institute]

UDC621.793.3

[Abstract] The outlook for utilizing nickel-boron coatings from solutions containing dimethylamine boranes (DMAB) for electronic circuitry depends mainly on the possibility of conducting the precipitation process using equipment which provides continuous control of solution composition and process conditions. Descriptions of this type of equipment appearing in the literature apply mainly to hypophosphite and boron hydride nickel plating solutions. Resolution of the automation problem

would facilitate intensification of the precipitation process, raise the level of production, and eliminate some of the ecological problems. In the present work a study was made of the possibility of re-using DMAB nickelizing solutions. Basic expendable component ratios of the solutions were determined and the theory for automatic adjustment of solution composition was developed. An apparatus was designed and tested for automatic adjustment of a chemical nickelizing solution employing DMAB. Figures 4; references 4 (Russian).

**Viscous-Elastic Solid Body Model Which Includes Mechanical Activation Effect**

927M0050C Ivanovo IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: KHIMIYA I  
KHIMICHESKAYA TEKHNLOGIYA in Russian  
Vol 34, No 6, Jun 91 (manuscript received  
11 Apr 91) pp 89-92

[Article by S. P. Bobkov, Chemical and Technological Institute, Ivanovo]

UDC66.022+66.021.3

[Abstract] The effect of the mechanical treatment of solid particles on their physical chemical properties and on the kinetics of any process in which they may be engaged has been the subject of intense research. While the complexity and many-sidedness of this problem have been determined, further theoretical and experimental research is hindered owing to the lack of a mathematical model which adequately describes the behavior of solid particles during mechanical treatment. In the present work the dissipation of mechanical energy during deformation of a solid body was examined from the standpoint of thermodynamically irreversible processes. A mathematical model is presented which takes into account both the elastic and viscous properties of a substance, as well as the absorption of energy, i.e. the mechanical activation effect. Figure 1; references 7 (Russian).

**Effect of Parameters of Mechanical Action on Its Effectiveness While Handling Solid Particles**

927M0050D Ivanovo IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: KHIMIYA I  
KHIMICHESKAYA TEKHNLOGIYA in Russian  
Vol 34, No 6, Jun 91 (manuscript received  
11 Apr 91) pp 93-96

[Article by S. P. Bobkov and A. N. Frolov, Chemical and Technological Institute, Ivanovo]

UDC66.022+66.021.3

[Abstract] Mechanical activation of the solid phase to intensify heterogeneous processes is gaining more and more attention in the development of newer types of chemical engineering equipment. By applying mechanical action, it is possible to make a significant impact on

the kinetics and extent of chemical processes. However, the relationship between the type and conditions of mechanical treatment and the extent to which the physical chemical properties of a solid substance are changed remains inadequately studied. Evidently, the type of action and its parameters have different effects on the solid phase particles. The data available to designers of chemical equipment is based mostly on experimental results and may be considered empirical or even subjective, and therefore a theoretical investigation of the effects of the parameters of mechanical action on the behavior of a deformed solid body is pressing. In the present work a study was made of the effect of the type deforming actions on the effectiveness of utilizing applied energy for a viscous-elastic solid body with mechanically activated effects. Strictly speaking, in real machines, the effects of the magnitude and shape of mechanical action on solid particles is arbitrary and random. However, even in the simplest cases, it is possible to draw conclusions. It may be concluded that in order to increase the effectiveness of mechanical treatment and lessen heat losses, it becomes necessary to use either single short impulses having steep fronts and with a significant number of high order harmonics, or periodic interaction with high frequency impulses. References 6 (Russian).

#### **Preparation and Use of Activated Charcoal in Potable Water Supply**

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TEKHNOLOGIYA* in Russian No 6, Nov-Dec 91  
(manuscript received 15 Jul 91) pp 27- 38

[Article by K. Ye. Makhorin, A. P. Maslyukov, and V. N. Aleksandrov, Colloidal Chemistry and Hydrochemistry Institute, Kiev]

UDC541.183:661.183.2

[Abstract] Most drinking water in the USSR is obtained from open reservoirs which are frequently contaminated with agricultural and industrial run-off. Treating water with chlorine makes it poor tasting and leads to formation of toxic and cancerogenic compounds. Drinking water in some parts of Ukraine contain 7 mg of organic contaminants per liter of water. Water in Kiev and Kharkov contain organic chlorine compounds; Odessa has pesticides, and Rubezhnoye, benzene and its derivatives. Potable water from these cities has been found to contain over 100 highly toxic organic compounds. Drinking water in developed countries is strictly controlled, but domestic water treatment plants not only fail to extract organic matter, but don't even analyze it. GOST 2874-82 limits only chloroform concentration,

although its maximum permissible concentration is frequently exceeded. During the period 1985-88 the chloroform content in 267 cities exceeded the maximum allowable concentration by 55 percent. In developed countries 34 percent of consumed activated charcoal is used to treat drinking water. In the USSR initial research on using activated charcoal for water treatment started in the 1950's. However, only 4.7 percent of that produced is currently used for water treatment because most of it is not suitable for this purpose. The major portion of domestic charcoal has a structure designated for gas and vapor treatment with few meso-pores required for removal of organic matter. The present survey of potable water supply treatment underscores the need for supplemental treatment at the home site by adsorption on micro- and meso-porous Donetsk anthracite sorbents contained in cartridges for use household use at the tap. Figures 8; references 11: 9 Russian, 2 Western.

#### **Preparation and Properties of Porous Ceramic from Finely Divided Aluminum Oxide**

927M0054B Kiev *KHIMICHESKAYA  
TEKHNOLOGIYA* in Russian No 6, Nov-Dec 91  
(manuscript received 15 Apr 91) pp 39- 45

[Article by A. P. Savitskiy, M. T. Bryk, and V. N. Pavlikov, Polytechnical Institute, Kiev]

UDC666.67

[Abstract] Porous ceramics may be prepared by sintering a powder (filler) having a definite particle size such as quartz, glass, or metal oxides, with a binder material. The latter may be liquid glass, clayey materials, aluminum phosphates, or polymers. To increase porosity, combustible materials such as sawdust, flour, starch, or sugar are sometimes added. By controlling the particle size of the powders, the amount and type of binder, and the type of heat treatment, it is possible to obtain ceramics with varying degrees of porosity and permeability. Recently, composite ceramic micro- and ultra-filters consisting of a robust and coarse pored substrate superimposed with an intermediate and fine pored working layer have been used for super-fine cleaning of liquid materials. In the present work carborundum samples having varying degrees of particle size were used as dispersed fillers to make rugged porous structures capable of withstanding temperatures over 1700°C. The following additives were used to help lower the calcining temperature: liquid glass, alumina- chromia-phosphate, and glass enamel. The effects of such process parameters as compression force, carborundum particle size, calcining temperature, and isothermal residence time were studied. A glass enamel frit of 0.2 micron particle size was prepared. Figure 1; references 10 (Russian).

### Cement from Extended Perlite Wastes

927M0054C Kiev *KHIMICHESKAYA  
TEKHNLOGIYA in Russian* No 6, Nov-Dec 91  
(manuscript received 15 Apr 91) pp 43-45

[Article by Ye. A. Myasnikova, O. P. Shestakova, N. L. Zaytseva, and Ye. V. Popova, Polytechnical Institute, Kiev]

UDC665.94:622

[Abstract] Perlite ore reserves are concentrated in Armenia (Aragatskiy deposit) and Ukraine (Beregovskoye deposit). The former produces 250,000 tons per year and the latter 150,000. Extending the perlite results in 5-20 percent waste consisting of crystalline inclusions incapable of extension, such as quartz, montmorillonite, and hydromica. Each enterprise produces an average of about 19,000 tons of waste annually. In the present work a study of the feasibility of utilizing these perlite wastes in the cement industry shows that the alumina-silica component can be used in portland cement clinker production as a corrective additive. The low iron oxides content also makes it possible to use it to produce white decorative cements. References 3 (Russian).

### Membrane Gas Fractionation Part 3. Fractionation of Air

927M0054D Kiev *KHIMICHESKAYA  
TEKHNLOGIYA in Russian*  
No 6, Nov-Dec 91 pp 46-56

[Article by V. L. Saprykin]

UDC532.711.7.66.92.081.6

[Abstract] Air fractionation by membrane appears to be highly promising. By 1995 it is expected that the outlays for membrane fractionation of air will exceed 100 million dollars annually. The present survey of patent and other literature of foreign companies lists the basic characteristics of polymer membranes for air fractionation, and the processes for drying and producing argon are reviewed briefly. Optimum processes and conditions for obtaining concentrated nitrogen and oxygen mixtures are presented, and the technical-economic specifications of membrane air fraction are compared with traditional methods. References 35: 4 Russian, 31 Western.

### Diffusion Model for Sorption of Iodine in Various Coal Sorbents

927M0054F Kiev *KHIMICHESKAYA  
TEKHNLOGIYA in Russian* No 6, Nov-Dec 91  
(manuscript received 17 Jul 91) pp 69-73

[Article by A. P. Maslyukov, L. F. Kiryanova, K. Ye. Makhorin, A. Ya. Polishchuk, N. N. Madyuskin, and A. L. Iordanskiy, Colloidal Chemistry and Hydrochemistry Institute, Kiev]

UDC546.05:541.183.661

[Abstract] The widespread use of coal sorbents in various branches of the national economy, including medicine, has generated an elevated interest in the physical chemical processes occurring between sorbents and the substances being adsorbed. In the case of iodine adsorption during potable water treatment, the properties of the sorbents used are pre-determined by the equilibrium and kinetic characteristics of the iodine-water system as a function of the sorbent's structure. Study of the kinetics of the sorption process makes it possible to determine its mechanism which is required for the prediction and evaluation of the efficiency of industrial leaching processes. The most promising trend in theoretical research on the above phenomena appears to be the development of an adequate model for iodine transfer near the surface of a sorbent particle and subsequently, the sorption process. In the present work the kinetics of iodine sorption from aqueous solutions on activated anthracite and synthetic adsorbent SKN was investigated. Iodine transfer in SKN occurs both by diffusion and by convection, while in the case of anthracite the process is mostly diffusion. The role of particle geometry in modeling was established, and an adequate model for iodine transfer in the vicinity of a sorbent particle surface was developed. Figures 3; references 5 (Russian).

### Modeling Oxides of Nitrogen Transformation in Power Plant Smoke Flares

927M0054G Kiev *KHIMICHESKAYA  
TEKHNLOGIYA in Russian* No 6, Nov-Dec 91  
(manuscript received 27 Sep 89) pp 91-94

[Article by A. M. Kuklin, N. A. Gurevich, and E. P. Dombrovskaya, Gas Institute, Kiev]

UDC662.613.5

[Abstract] Mathematical modeling is an effective means for studying the transformation of pollutants present in the smoke flares of thermal electric power stations. A major difficulty in modeling chemically active substances is the need for a formal description of the simultaneously occurring processes of diffusion and chemical kinetics. Although significant progress in modeling each of these processes has been made, a model which adequately describes both processes has not yet been derived. Analysis of published models of nitrogen oxides transformation in smoke flares of power plants reveals that in computing ground level concentrations of NO<sub>2</sub> it is required to mathematically separate the chemical transformation process from that of diffusion. At the present time this achieved by assuming photochemical equilibrium in the nitrogen oxides-ozone system. At the Gas Institute a diffusion-kinetic model for oxidation of NO into NO<sub>2</sub> in power plant smoke flares was developed and used to study the effects of the source and the environment. The model, consisting of kinetic and diffusion blocks, has two versions and makes it possible to compute concentration fields of NO, NO<sub>2</sub>, NO<sub>x</sub> and O<sub>3</sub> in the smoke flare. A non-linear relationship exists between drop in total NO<sub>x</sub> emission and the decrease in ground level NO<sub>2</sub> concentration. Figures 2; references 6 (Russian).

**Composition of Gas Emission from Artificial Leather Production**

927M0054H Kiev *KHIMICHESKAYA  
TEKHNOLOGIYA* in Russian No 6, Nov-Dec 91  
(manuscript received 27 Sep 89) pp 99-100

[Article by N. Yu. Pavlyuk and V. L. Aksenov, Gas Institute, Kiev]

UDC662.61:628.83

[Abstract] Ecologically clean industry requires the need for closed cycle production processes where gaseous wastes are consumed in boiler furnaces instead of being vented to the atmosphere. This not only consumes the pollutants, but may also provide some savings in energy consumption. A study was made of the composition of gaseous emissions resulting from artificial leather production at an embossing-calendaring shop in Zaporozhye where color printing and welding take place emitting ethyl acetate, benzene, and acetone. The possibility of neutralizing these wastes by feeding them to boiler furnaces is evaluated. References 3 (Russian).

**Development and Realization of Pyrolysis Furnace Fuel Systems Using Acoustic Gas Burners**

927M0063A Moscow *KHIMICHESKAYA  
PROMYSHLENNOST* in Russian No 7, Jul 1991  
pp 396-398

[Article by A. S. Malinovskiy, S. P. Chernykh, T. N. Mykhina, V. V. Sharikhin, N. R. Entus, and A. N. Kezin]

UDC 66.041.454.002.237

[Abstract] In order to increase rotary furnace efficiency and to prevent coke deposition, the pyrolysis furnaces in the Kuybyshevskiy Synthetic Alcohol Factory were reconstructed, with assistance from the Kuybyshevskiy Polytechnic Institute and the All-Union Scientific Research Institute of Organic Synthesis. The Russian PBPSH burner and the American PMS-3 burner from John Zink were used as models. A new acoustic gas burner was developed, with a productivity of 300 m<sup>3</sup>/hr at a pressure of 0.5-2.5 kg sec/cm<sup>2</sup>. The new burner was compared to the older burner by mounting both in the same furnace. These tests showed that the new burner had a thermal power of 2066 kW, compared to 243 kW for the older burner. With eight acoustic burners furnace temperature was almost completely uniform, permitting a simpler construction design. An improved acoustic burner was developed, with optimized dimensions. This burner exhibited high efficiency and complete fuel combustion. Under license from John Zink, the four versions of the acoustic burner have been installed in more than 200 furnaces, permitting optimization and automation of their functions, which is estimated to have saved more than 5 million rubles. References 1: Russian.

**Aluminum Nickel Catalyst for Hydrogenation of Butyraldehyde into Butyl Alcohol**

927M0063B Moscow *KHIMICHESKAYA  
PROMYSHLENNOST* in Russian No 7, Jul 1991  
pp 404-405

[Article by A. G. Rakhimkulov, and I. Z. Akhmerov]

UDC 66.094.173:[661.7:547.281.4]

[Abstract] The hydrogenation of butyraldehyde using aluminum-nickel catalysts with particle sizes of 0.5-1 mm was investigated, in order to eliminate temperature spikes observed with current catalysts. Experiments were conducted in a jacketed long-neck flask reactor whose oscillation could be varied from 0 to 10 per second. Preliminary experiments established that use of catalyst with particles of 0.5-0.7 mm diameter relieved internal diffusion inhibition so that the reaction could proceed in the kinetic zone. The activity of the experimental catalyst was greater than that of industrial catalyst by a factor of two. When both catalysts were subjected to preliminary thermal treatment, their activity and surface area decreased, and this effect was greater at higher temperatures. One may conclude that the decrease in activity observed during the use of industrial catalyst is caused by decreases in surface area due to temperature spikes. When the experimental catalyst was used under industrial conditions, it maintained activity for fourteen months and increased reactor productivity by 10%. Figures 2; References 3: Russian.

**Results of Testing and Methods for Intensifying Multiton Production of Unconcentrated Nitric Acid**

927M0063C Moscow *KHIMICHESKAYA  
PROMYSHLENNOST* in Russian No 7, Jul 1991  
pp 411-414

[Article by V. M. Olevskiy, V. S. Mislavskaya, M. Ye. Skvirskiy, and N. V. Yurgenson]

UDC 661.56.002.237

[Abstract] The Chirchikskiy Elektrokhimprom factory tested the modernized AK-72M equipment for producing nitric acid in 1988. The areas of equipment modernization included catalytic purification of exhaust gas, heating of exhaust gas, chiller-condensers at two stages of the process, and improved design of scrubbers and waste heat boilers. Corrections to the design of the ammonia evaporator were required to prevent sudden increases in the temperature of the cooling water. Experiments with five catalytic grids demonstrated that seven grids are needed to completely eliminate nitrite-nitrate salt formation. Cooling of the upper coil made it possible to produce acid with a NO<sub>x</sub> concentration of 58-60%. An aluminum-copper catalyst was used to purify effluent gas, reducing nitrogen oxides to ammonia, but the ammonia concentration in the purified gas was more

than anticipated. Improvements in the construction of the effluent gas block heater and the waste heat boiler are still needed. Nevertheless the modernized equipment improved productivity by 8-12%. References 3: Russian.

**Use of Magnetic Filtration to Increase the Quality of Ammonia in Nitric Acid Production**

927M0063D Moscow *KHIMICHESKAYA*  
*PROMYSHLENNOST* in Russian No 7, Jul 1991  
pp 414-416

[Article by N. V. Yatskov, A. V. Sandylyak, and B. L. Dakhnenko]

UDC 66.067.1:538

[Abstract] Analysis of the degree of conversion achieved by the seven contact surfaces in the Rovenskiy "Azot" plant for nonconcentrated nitric acid demonstrated that over six years output began to decrease after the first three months of use, and eventually decreased by 4-6%. Linear regression analysis of degree of conversion versus days of use gave an intercept of 91.78% and a slope of -0.075%/day. This decrease in conversion was found to be a function of the amount of iron and oil impurities in the starting ammonia. Each mg/L of iron decreased output by 0.59% and each mg/L of oil by 0.52%. Analysis of the deposits found on the platinum catalytic grids revealed that 38.4% of the deposits were iron, suggesting that magnetic filtration might be effective. This filtration was conducted on both liquid and gaseous ammonia, resulting in 95-97% purification. A 10-30% decrease in oil content was also achieved. The use of magnetic filtration of ammonia increased the degree of conversion to nitric acid by 1-2%. Figures 3; references 9: Russian.

**Automated Calculation System for Encapsulation of Ammonium Nitrate Granules in Pseudofluidized Layer Apparatus**

927M0063E Moscow *KHIMICHESKAYA*  
*PROMYSHLENNOST* in Russian No 7, Jul 1991  
pp 436-437

[Article by Ya. I. Rustamov, G. A. Karamamedov, and G. T. Shakhbazova]

UDC 66.011:631.842.67.096.5

[Abstract] A twelve-equation mathematical model was developed for automation of ammonium nitrate encapsulation in pseudofluidized layer apparatus. The first two equations characterized the dependence of the true and apparent granule density on the thickness of the capsule-forming film. Three equations described the interaction between initial fluidization rate, granule removal, and a modified Archimedes' criteria. Three equations represent the dependence of the granule time distribution function on kinetic and technological parameters. Heat and mass transfer between phases, rate of solvent removal and continuous process balance are

involved in the remaining equations. From the equations a scheme was constructed which permitted calculation of all apparatus parameters. A Fortran program was written and used to calculate the ranges, optimum values, and interdependences of critical parameters. Figures 2; references 5: Russian.

**Nonstationary Filtration of Dusty Gas**

927M0063f Moscow *KHIMICHESKAYA*  
*PROMYSHLENNOST* in Russian No 7, Jul 1991  
pp 439-442

[Article by V. P. Kurkin]

UDC 66.074.6.001.57

[Abstract] The theoretical bases of a nonstationary regime of dust removal from gas were investigated. At the beginning of filtration a layer of captured particles forms on the filter, which increases the subsequent removal of large particles. The disperse mass input function determines the effectiveness of mass deposition on the filter, and is called dust removal efficiency. Disperse mass movement is quasistationary, since layer growth is much slower than gas flow rate. A parabolic differential equation was derived describing the dependence of mass flow, time and layer coordinates. The equation permits description of the effect of inertial forces, direct impact, and Brownian (for submicron particles) forces on filtration. The relationships derived were verified using data obtained for the filtration of quartz dust from air using glass fiber filters and for removal of metaboric acid and raw material residues from boron carbide fusion flue gas. Figures 5; references 3: Russian.

**Determining Reliability of Nondestructive Control Results for Apparatus Wall Thickness**

927M0063G Moscow *KHIMICHESKAYA*  
*PROMYSHLENNOST* in Russian No 7, Jul 1991  
pp 442-444

[Article by R. G. Mannapov and N. V. Khimchenko]

UDC [66.023:620.193]:65.012.7

[Abstract] The technical state of apparatus may worsen as a result of general corrosion, metal fatigue cracking, and changes in mechanical properties due to working environment influences. An approach to the evaluation of thickness control reliability is presented, which was developed by the Khimmashe Scientific Research Institute for chemical industry equipment. While measurement error with an ultrasound thickness gage was negligible, the largest source of error was initial



nonhomogeneity in the thickness of the sheet metal used, and uneven corrosion. The concept of distribution of corrosion depth, the Beybull rule, was used to deal with this high degree of variability. The approach developed was applied to an ethylene oxide production absorber in use since 1966. An equation was developed

for measurement reliability, defined as the probability of absence of any thickness below that calculated, in terms of area, initial thickness distribution, Beybull distribution parameter, mean corrosion depth, corrosion variability, and number of measurements. Figures 2; references 3: Russian.



### Adsorption of Hydrogen on Carbon Fiber Electrodes

927M0053A Moscow ELEKTROKHIMIYA in Russian Vol 27, No 7, Jul 91 (manuscript received 19 Sep 88, after revision 25 Dec 89) pp 842-847

[Article by A. A. Vedenyapin, A. Yu. Krylova, O. A. Malykh, T. I. Kuznetsova, G. I. Yemelyanova, A. G. Gazaryan, A. L. Lapidus, and S. V. Yushin, Organic Chemistry Institute imeni N. D. Zelinskiy, Moscow]

UDC541.135.5

[Abstract] Carbon fibers, resistant to chemicals and heat, mechanically strong but resilient, and having a wide range of specific surface, are currently being used in many fields of electrochemistry and catalysis. Metal catalysts, carried on these fibers, are active in electrooxidation, Fischer-Tropsch synthesis, and are useful as membranes and in fuel cells. The fibers are also used in electroanalytical analysis, although detailed research on these materials is lacking. In the present work the adsorption and catalytic properties of carbon fibers having 64 m<sup>2</sup> per gram surface area were studied. Potentiodynamic analysis shows that redox processes occur both on the surface and within the bulk. At 0.2 - 1.0 volt, two types of sites exist on the carbon fiber surfaces, which participate in both redox processes and cathode evolution of hydrogen. Figures 5; references 18: 10 Russian, 8 Western.

### Platinum Electrocatalysts on Carbon Fiber Carriers

927M0053B Moscow ELEKTROKHIMIYA in Russian Vol 27, No 7, Jul 91 (manuscript received 19 Sep 88 after revision 9 Jul 90)

[Article by A. A. Vedenyapin, A. Yu. Krylova, A. G. Gazaryan, T. I. Kuznetsova, O. A. Malykh, G. I. Yemelyanova, A. L. Lapidus, and S. V. Yushin, Organic Chemistry Institute imeni N. D. Zelinskiy, Moscow; Moscow State University imeni M. D. Lomonosov]

UDC541.135.5-183

[Abstract] Carbon fiber may be used to prepare rugged and corrosion-resistant catalysts. In the present work platinum on carbon fiber catalysts were prepared both by impregnation and electrochemical precipitation. Apparently, two types of polarization processes having different reaction rates take place on the catalyst surface. A method is proposed for computing physical chemical constants such as specific surface, metal crystal size, and quantity of adsorbed hydrogen on these catalysts. Catalysts prepared by precipitation are more finely divided

than those prepared by impregnation. Figures 5; references 6: 5 Russian, 1 Western.

### Effect of Porous Structure on Hydrogen Evolution Process on Platinum Electrodes

927M0053C Moscow ELEKTROKHIMIYA in Russian Vol 27, No 7, Jul 91 (manuscript received 21 Sep 90) pp 864- 870

[Article by B. I. Podlovchenko, Yu. M. Maksimov, G. -Y. Geydrikh, T. L. Azarchenko, and L. Myuller, Humboldt University, Berlin; Moscow State University imeni M. V. Lomonosov]

UDC541.138.3

[Abstract] Increasing the surface area of an electrode is often used to further intensify an electrode process. However, in many practical electrochemical processes associated with gas evolution, the relationship between overvoltage and electrode pore structure has not been well studied. It has been demonstrated that the rates of hydrogen evolution from acid solutions over porous electrolytic coatings of platinum and rhodium per unit of geometric surface are practically the same as on smooth Pt and Rh, i.e. the pores are not "working" during gas evolution. This was explained as being due to super saturation in the pores causing a shift in reverse hydrogen potential to values equal to the externally applied potential, thereby inhibiting hydrogen transfer from pores having radii of 1.5-2.0 nm. In the present work polarization curves and potential drop following circuit breaking curves were compared for smooth platinum, Pt/Pt, and pressed and calcined platinum black during hydrogen evolution from 0.5M sulfuric acid and 1M NaOH. In all cases hydrogen evolution was practically the same and the conclusion regarding the pores not "working" due to impeded hydrogen mass transfer was confirmed. Figures 6; references 22: 10 Russian, 12 Western.

### Catalytic Evolution of Hydrogen in Presence of Rhodium (II) Complexes

927M0053D Moscow ELEKTROKHIMIYA in Russian Vol 27, No 7, Jul 91 (manuscript received 25 Jun 90) pp 877- 881

[Article by R. K. Astakhova, S. R. Balushkina, A. B. Belenkiy, and B. S. Krasikov, Leningrad State University]

UDC541.138.6+546.98

[Abstract] A pronounced catalytic effect has been observed during evolution of hydrogen over a mercury electrode in the presence of complex rhodium compounds. A mechanism was proposed where the electron

addition stage is preceded by a decomposition stage. In the present work an attempt was made to clarify the mechanism of hydrogen evolution in the presence of acetate binuclear rhodium (II) complexes using a dropping mercury electrode and an electrode in the form of a hanging mercury drop. It is hypothesized that catalytic hydrogen evolution takes place in both cases via electrochemical desorption, the limiting stage being addition of the primary electron.

#### Interferometric Method for Measuring Limiting Current Density of Diffusion on Ion Exchange Membranes

927M0053E Moscow ELEKTROKHIMIYA in Russian Vol 27, No 7, Jul 91 (manuscript received 27 Aug 90) pp 891- 895

[Article by V. A. Shaposhnik, V. I. Vasilyeva, and K. Kessore, Voronezh State University imeni Lenin Komsomol]

UDC541.13:621.359.7

[Abstract] The limiting current density concept was first proposed by E. Brunner in 1904 while studying the kinetics of electrode reactions, and later extended by A. Peers by analogy to electro-mass transfer through ion exchange membranes. It had been established that an increase in limiting diffusion currents results in formation of deposits on the membranes, thereby becoming a basic limiting factor in mass transfer during electrodialysis. Determination of limiting current density for each concrete case thus became a necessity. In the present work a helium-neon laser interferometric technique was employed to determine limiting diffusion current density in electro-membrane systems. The proposed method may be used in those cases where other methods, such as the volt-ampere technique, are not convenient. Figures 4; references 9: 7 Russian, 2 Western.

#### The Effect of Cation Nature on the Electrochemical Reduction of Anionic $\sigma$ -Complexes

927M0038F Leningrad ZHURNAL OBSHCHEY KHIMII in Russian Vol 61 No 3, Mar 91 (manuscript received 27 Feb 89) pp 563-566

[Article by N.D. Stempin, S.S. Gitis, A.I. Glaz (deceased), and I.V. Shakhkeldyan, Tula State Pedagogical Institute imeni L.N. Tolstoy]

UDC 547.546.543.253

[Abstract] In previous communications, the authors of the study reported herein demonstrated that the electrochemical reduction of Jackson-Meisenheimer  $\sigma$ -complexes is a rather convenient method to use in studying the effect of different factors on the state of the nitro groups in these compounds. They further established that these adducts form different types of ionic pairs in low-polarity media. Because information does not yet exist regarding the participation of ortho-nitro groups in the formation of such agglomerates, the authors used the cathodic polarography method to study the effect that cation nature has on the electrochemical reduction of anionic  $\sigma$ -complexes. As study objects they used spirocyclic trinitro complexes with cations of different s-, p-, and d-elements and  $\sigma$ -complexes (I), as well as spiro complexes (II) based on 2,4,6-trinitroanisole, 2,4-dinitrophenol (III), and 1-methoxy-2,4-dinitronaphthalene (IV) with alkaline metal cations. All of them give off distinct polarographic waves in dimethyl sulfoxide [DMSO] against a background of tetraethyl ammonium iodide. All polarographic measurements were made by using an LP-7 polarograph in a thermostatted cell. The studies performed established that the half-wave's potential depends on the radius and electronic structure of the ion. Given identical charges, a cation's effect on the state of the nitro group weakens as its radius increases. This in turn causes the half-wave's potential to shift to a more negative range of values.  $Mg^{2+}$  and  $Al^{3+}$  were found to cause the greatest negative potential shifts.  $Zn^{2+}$ ,  $Cd^{2+}$ ,  $Ag^+$ ,  $Tl^+$ ,  $Pb^{2+}$ , and  $Bi^{3+}$  had a lesser but still quite noticeable effect. In the case of the latter three ions, the potential shift was also found to depend on the ion's radius and charge. Tables 2; references 6 (Russian).

**Gas-Chromatographic Express-Method of Determining Organic Chloride Insecticides in Aqueous Media**

927M0061A Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13, No 11, Nov 1991 pp 987-991

[Article by M. A. Galaktionova and L. V. Nevinnaya; Institute of Colloid Chemistry and Chemistry of Water imeni A. V. Dumanskiy; Ukrainian Academy of Sciences, Kiev]

UDC 543.38:543.544

[Abstract] Development of an express-method of determining organic chloride insecticides [isomers of hexachlorocyclohexane, DDT and its analogs] in water for control of adsorption experiments proceeded from previously obtained data showing that the ratio of aqueous solution of the organic chloride insecticides to the sorbent should be at least  $10^3$ : $10^4$ :1 and the minimum volume of the analyzed water sample should be 100 ml. Use of the new method made it possible to reduce the volume of the sample analyzed from 2 liters to 100 ml, to use 1-fold instead of 3-fold extraction and a modulus of extraction equal to 50-100 instead of one equal to 10. The drying stage of the hexane extract and the evaporation stage when determining gamma-isomers of hexachlorocyclohexane may be excluded. An analysis lasts from 15-30 minutes with margin of error not exceeding 3-5 percent. The method has been used to develop an adsorption method of removing residual quantities of pesticides from tap water. Figures 2; references 8: 4 Russian; 4 Western.

**Methods of Preventing Scale Formation During Desalination of Salt Waters**

927M0061B Kiev *KHIMIYA I TEKHOLOGIYA VODY* Vol 13, No 11, Nov 1991 pp 996-1013

[Article by A. T. Pilipenko, I. G. Vakhnin, V. I. Maksin and Z. A. Samchenko; Institute of Colloid Chemistry and Chemistry of Water imeni A. V. Dumanskiy; Ukrainian Academy of Sciences; Kiev]

UDC 628.16(088.8)+628.143.23

[Abstract] A survey of the literature provided data for summarizing and analyzing results of scientific and practical investigations concerning prevention of scale formation from 1984-1990. Examples of practical use of physical, chemical and physico-chemical methods of preventing scale formation during water desalination were presented, described and discussed. References 215: 107 Russian; 108 Western.

**Removal of Cesium-137 and Strontium-90 From Water By Use of Natural and Activated Laminar and Laminar-Band Silicates**

927M0061C Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13, No 11, Nov 1991 pp 1025-1029

[Article by B. Yu. Kornilovich, G. N. Pshinko, A. A. Kosorukov, Institute of Colloid Chemistry and Chemistry of Water imeni A. V. Dumanskiy; Ukrainian Academy of Sciences; Kiev]

UDC 549.6:541.18.053

[Abstract] A study of processes of sorption of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  by basic representatives of dispersed silicates used prepurified kaolinites of Glukovetskoye and Glykhovskiy deposits (UkSSR), montmorillonites of Cherkassy (UkSSR) and Oglanlin (TSSR) deposits, palygorskite of Cherkassy deposit and a natural mixture of montmorillonite and palygorskite of Cherkassy deposit and included examination of the possibility of preliminary mechanochemical and thermochemical activation of natural minerals in order to increase their capacity to extract radionuclides from water. Thermal processing of the minerals proved to be ineffective in increasing their sorption capacity under the conditions studied. Mechano-chemical activation, however, increased the dispersity of the particles and structural changes associated with them; especially the ordering of the octohedral layer and introduced significant distortions in the tetrahedral network while preserving the basic structural motive of the latter and ensuring growth of the pseudohexagonal silicate craters which is most important for sorption of  $\text{Cs}^+$  active centers. Figures 2; references 10: 5 Russian; 5 Western.

**Complex Processing of Back Waters of Petroleum Deposits**

927M0061D Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13, No 11, Nov 1991 pp 1036-1040

[Article by V. V. Starkov and R. I. Iovchev; All-Union Research Institute of Hydrogeology and Geological Engineering; Moscow]

UDC 66.011/556.3:553.982/

[Abstract] A process flow diagram for complex processing of mineralized back waters of a sodium-chloride type of petroleum deposit was developed on the basis of laboratory studies. The scheme was based on precipitation methods and was used to process water containing (g per liter) magnesium-0.48, calcium-5.82, strontium-0.64, lithium-0.035, rubidium-0.002, cesium-0.0005, boron-0.090, bromine-0.235, iodine-0.010, potassium-0.70, sodium-27.0, chlorine-51.5, mineralization-85.8. The complex technology yielded needed products

including iodine and bromine compounds, sodium perborate, calcined magnesium, lithium carbonate, strontium carbonate, calcium hypochlorite, table salt and fresh water for technical and economic uses. The profitability of the plant operating the process was 10-15 percent. Most of the production is used in the immediate vicinity. References 16: 15 Russian; 1 Western.

**Desorption of Volatile Organic Substances From Activated Carbon in Distillation Circuits of Municipal Sewage at Thermal Power Stations**

927M0061E Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13, No 11, Nov 1991 pp 1047-1050

[Article by Yu. V. Shilovskiy, K. M. Abdullayev, I. A. Malakhov and A. M. Koganovskiy; Azerbaijan Institute of Oil and Gas imeni M. Azizbekov; Baku; Institute of Colloid Chemistry and Chemistry of Water imeni A. V. Dumanskiy; Ukrainian Academy of Sciences; Kiev]

UDC 621.311.22:628.387.2

[Abstract] Development of an effective method of regenerating activated carbon BAC after desorption of volatile organic substances from municipal sewage distillate by use of sequential extraction of the adsorbed substances by alkali and acid solutions was described and discussed. The method employed ionization of the adsorbed acids in an alkaline medium and ionization of the organic bases in an acid medium, producing their desorption from the carbon. Volatile non-electrolytes were removed from the carbon by processing by water vapor at a temperature no lower than the temperature of the vapor in the evaporator. Regeneration of the carbon was performed by 3-fold repetition of a cycle involving sequential processing of the carbon by 4 percent sulfuric acid and by

water vapor at 160°C, a 4 percent NaOH solution and secondary treatment of the carbon with water vapor at 160°C and 0.6 MPa. Use of this technology produced a sorptional capacity equal to that of fresh carbon. Regeneration required 2.0-2.5 days. Figures 5; references 3 (Russian).

**Microbial Treatment of Sewage From Cationic Surfactants Production**

927M0061F Kiev *KHIMIYA I TEKHOLOGIYA VODY* Vol 13, No 11, Nov 1991 pp 1051-1056

[Article by L. A. Taranov, S. V. Grishchenko, O. S. Radchenko et al.; Institute of Colloid Chemistry and Water Chemistry; Ukrainian Academy of Sciences; Kiev]

UDC 579.695

[Abstract] A study of the removal of nitriles and alkyldimethylamines from sewage from cationic surfactants production by a running aerobic bioreactor used an association of bacteria *P. stutzeri*, *Pseudomonas* sp, *Alcaligenes denitrificans* and *Citrobacter freundii* in a ratio of 61, 33, 2.6, 3.4 percent. Optimum purification occurred at an initial concentration of pollution of 3.0-3.5 g/dm<sup>3</sup> according to chemical consumption of oxygen and 18-24 hours of aeration. Use of <sup>1</sup>H and <sup>13</sup>C nuclear magnetic resonance identified intermediate and end products of destruction. The association of bacteria ensured a degree of purification of industrial waters of cationic surfactants production, using xenobiotics in their composition as sources of carbon, nitrogen and energy, sufficient to permit their discharge into biological purification installations. Figure 1; references 6: 5 Russian; 1 Western.

**Excitation and Resonance Fluorescence Spectra of Gaseous Lead Diiodide**

927M0049A Moscow VESTNIK MOSKOVSKOGO  
UNIVERSITETA: SERIYA 2, KHIMIYA in Russian  
Vol 32, No 4, Jul-Aug 91 (manuscript received  
24 Sep 90) pp 329-333

[Article by S. A. Zaytsev, A. P. Monyakin, A. V.  
Buchkin, and V. A. Koryazhkin, Chair of Physical  
Chemistry]

UDC535.34.817

[Abstract] Published data on the optical properties of lead diiodide refers mainly to crystals and films. In the present work the structure of this compound in the gaseous phase was studied by excitation of the molecule with a pulsed re-tuned laser on dyes with liquid nitrogen pumping. An automated multi-functional device made it possible to record laser resonance fluorescence and laser excited fluorescence spectra. The energy of the lower electron state and the vibrational frequencies of lead diiodide in the gaseous phase were determined. Figure 1; references 14: 4 Russian, 10 Western.

### An Electromembrane Technology To Clean Sodium Salts From Industrial Pentaerythrite Solutions

927M0027D Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 319 No 3, Jul 91 (manuscript received 1 Apr 91) pp 679-682

[Article by A.A. Tskhay, Z.A. Shishkina, and U.T. Isenzhulova, Chemical Sciences Institute, Kazakhstan Academy of Sciences, Alma-Ata]

UDC 66.087.97:661.725.8

[Abstract] The authors of the study reported herein worked to develop a process to clean sodium salts from industrial pentaerythrite solutions. They subjected a pentaerythrite solution to desalination in a multiple-chamber electrodialysis unit with MK-40, MA-40, MK-44, and MA-41I ion-exchange membranes. Each membrane had a working surface of 90 cm<sup>2</sup>, and the membranes were spaced 0.12 cm apart. Industrial pentaerythrite solutions containing between 43 and 59 g/l sodium formate were desalinated to a residual sodium formate concentration of 3-4 g/l in a galvanostatic mode. Studies were performed to determine the kinetics of electrodialysis desalination of the compound on different membrane pairs, the effect of the degree of concentration of sodium formate from the industrial pentaerythrite solution on the current efficiency and specific consumption of electric power, and the water permeability of the spent membranes. The only membrane to undergo a significant change in selectivity after use was the MA-40. The new process was tested in the cleaning of pentaerythrite solution on an EDU1-400 x 6 commercial electrodialysis unit. The unit had a capacity of 1,200 l/h while reducing the sodium formate concentration from 48 g/l to 2 g/l. The E-400 electrodialysis device used in the EDU1 units is intended to desalinate salted waters with a mineralization of 3 to 8 g/l. For this reason, the membranes were observed to be burned through when highly concentrated solutions were desalinated. This burning was caused by current leakages along the feeder collectors. In addition, leakages between the tracks inside the device were found to reduce the efficiency of the cleaning process. To remedy these problems and to implement their new process for electrodialysis cleaning of pentaerythrite solutions, the authors developed a new electrodialysis device. The device's intermembrane spacer has a system of incoming and outgoing collectors extending beyond the membrane's overall dimensions. This makes it possible to eliminate leakages between tracks, reduce current leakages, and increase the amount of usable ion-exchange surface space. Figures 4, table 1; references 7: 4 Russian, 3 Western.

### Study of Diffusion of S, Se, and Bi in High Temperature Superconducting Ceramic Materials

927M0054E Kiev KHIMICHESKAYA TEKHNLOGIYA in Russian No 6, Nov-Dec 91 (manuscript received 25 Jun 91) pp 60-65

[Article by P. P. Gorbik, M. V. Bakuntseva, and G. M. Shalyapina, Surface Chemistry Institute, Kiev]

UDC537.312.539

[Abstract] Research on the diffusion of cations and anions in dispersed, bulk, and filmy materials and coatings of high temperature superconductors has become critical from the standpoint of preparation and application. Structural peculiarities such as lamination and vacancies could lead to variations in migration processes and affect critical parameters and stability. In the present work radioactive tracers were used to study the diffusion of sulfur, selenium, and bismuth in the ceramics YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7-δ</sub> and (Pb<sub>x</sub>Bi<sub>1-x</sub>)<sub>2</sub>Ca<sub>2</sub>Sr<sub>2</sub>Cu<sub>3</sub>O<sub>y</sub>. Two types of diffusion processes, viz. rapid and slow, were detected which could be related to surface and bulk diffusion. Also, a shift in the diffusion mechanism of sulfur at 300° C in the first ceramic was detected which is probably related to the generation of vacancies in the basic Cu-O plane. Diffusion parameters were experimentally determined for the diffusion of D<sub>O</sub> and E<sub>a</sub>. Figures 2; references 20: 12 Russian, 8 Western.

### An Investigation of the Surface of Carbon Fiber After High-Frequency Discharge Oxygen Plasma Treatment

927M0055B Moscow POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA in Russian No 9, Sep 91 (manuscript received 6 Mar 90; after revision 22 May 90) pp 11-15

[Article by A.Ye. Razumayeva and B.V. Strakhov (deceased), Chemistry Department, Moscow State University imeni M.V. Lomonosov]

UDC 677.494.745.32+533.924

[Abstract] The authors of the study reported herein examined the surface of carbon fiber that had been treated with high-frequency discharge oxygen plasma. The study fiber was produced from polyacrylonitrile and treated in a vacuum discharge stream unit at a system pressure of 1 torr and with an oxygen flow speed of about 0.3 l/h. An electrodeless high-frequency discharge was generated by a Luch-58 plasma generator with a basic frequency of 2400 MHz and a power of about 60 W. A DS-403G high-resolution spectrophotometer with a diffraction grating was used to record transmission spectra in the range from 200 to 4,000 cm<sup>-1</sup>. A nondestructive full internal reflection spectroscopy attachment was also used. An updated MI-1305 mass spectrometer was used to obtain the curves of the carbon fiber's heat desorption. This was accomplished by gradually heating the specimen under conditions of evaporation from an open surface or continuous evacuation of the mass spectrometer's vacuum system. The thermal desorption products were identified on the basis of the relationships of the intensities of the characteristic peaks of the mass spectra of the study substances. The specific surfaces were determined by the method of thermal desorption on argon on a Tsvet-211 unit. Electron microscopy studies were also conducted on an electron microscope at a magnification of 2,000x. The studies performed indicated that treating



carbon fiber in oxygen plasma results in a slight increase in fiber surface and in an increase in functional groups by about an order of magnitude when calculated for both 1 g and 1 m<sup>2</sup> of specimen. The said plasma treatment resulted in the elimination of surface defects associated with the presence of residues of the low-molecular layer and resulted in only slight changes in specific surface, total pore size, and distribution of pores along the study carbon fibers' radii. Figures 3, tables 2; references 8: 5 Russian, 3 Western.

#### **Epitaxial Gallium Nitride Films on Sapphire: Their Electrical and Optical Properties**

927M0055D Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 9, Sep 91 (manuscript received 5 Mar90; after revision 23 May 90) pp 40-44

[Article by S.I. Vlaskina, A.Yu. Dyban, N.V. Kitsyuk, V.Ye. Rodionov, and L.R. Shaginyan, Semiconductors Institute, UkSSR Academy of Sciences, Kiev]

UDC 621.382.621.793.1:537.534

[Abstract] The authors of the study reported herein examined the electrical characteristics and photoluminescence of GaN films deposited on sapphire substrates by the method of reactive thermoion plating. The volt-ampere characteristic of the test material was measured on a 14 TKS-100 automated tester, and the photoluminescence spectra of the test materials were studied on an SDL-1 spectrometer at temperatures of 77 and 300 K. An EMR-100 electronograph was used to examine the structure of the study films, and their composition was determined by Auger analysis on a JAMP-10S. The studies performed indicated that the reactive thermoion plating method results in GaN films on sapphire substrates that are competitive with GaN films produced by chemical methods. GaN films produced by reactive thermoion plating was found to possess an increased monocrystallinity. This increased monocrystallinity was, at increased film thicknesses, accompanied by a reduction in the films' oxygen content. This change in oxygen content had several consequences. Specifically, it resulted in the disappearance of the maximum in the test films' photoluminescence spectra in the red ( $\lambda = 590$  nm) region of the spectrum and a shift to the light blue region ( $\lambda = 450$  nm). It also resulted in a reduction in electrical conductivity on account of a reduction in the concentration of free carriers. Yellow electroluminescence ( $E = 2.2$  eV) was found on specimens of GaN deposited on sapphire bases by the reactive thermoion method. On the basis of the studies performed, the authors recommended the reactive thermoion method as a relatively easy to monitor and easy to replicate way of producing monocrystalline GaN films suitable for use in manufacturing semiconductor instruments. Figures 4, table 1; references 12: 4 Russian, 8 Western.

#### **Using Silicon Nitride Films Deposited at Room Temperature To Preserve the Homogeneity of Aluminum Metallization Layers**

927M0055F Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 9, Sep 91 (manuscript received 29 Mar 90; after revision 3 May 90) pp 59-66

[Article by N.M. Rubtsov, S.S. Nagornyy, A.S. Saprykin, and V.I. Zakharin, Fizika Scientific Production Association, Moscow]

UDC 621.316.8-416.002

[Abstract] The authors of the study reported herein examined the possibility of using silicon nitride films deposited at room temperature as a way of preserving the homogeneity of aluminum metallization layers produced by the method of magnetron sputtering. The study structures were formed on 76-mm-diameter type KEF-4.5 silicon wafers with an orientation of (100). The method of oxidation in dry oxygen at 1,373 K was used to grow a thermal oxide layer (thickness, 600 angstroms) on the wafers. After having been thus prepared, the substrates were sputtered with an aluminum film 0.6  $\mu$ m thick under a vacuum of  $3 \times 10^{-5}$  Pa. The target contained Al plus 1% Si. The process was implemented under a pressure of 0.4 Pa and a temperature of 480 K with a discharge power of 3 kW. The resultant films had a specific resistance of  $3.3 \times 10^{-6}$   $\Omega$ -cm, and the variation of their thickness on each wafer did not exceed 5%. Wafers with and without a silicon nitride layer were subjected to heat treatment at a temperature of 473 or 523 K in nitrogen under a pressure of 30 Pa for 5 minutes. The number of projections on the metal film's surface was estimated by using an optical microscope (magnification, 200x). Individual segments of the test structures were studied by scanning electron microscopy. The studies performed enabled the authors to propose a model that in turn made it possible to explain the appearance of a density maximum of chips formed during the heat treatment of sputtered aluminum films. In very basic terms, high heat treatment temperatures resulted in large chips and, in some cases, in the formation of chips that grew in a crystallographically oriented manner. The authors further concluded that consideration must be given to the relaxation of mechanical stresses in aluminum films between the operations of sputtering and heat treatment. Unless this relaxation is taken into account, the theoretical formulas that have been derived to describe the sputtering and heat treatment process would indicate that chips cannot form at temperatures of  $T \leq T_0$  (even though theoretical computations would indicate otherwise). The phenomenon of relaxation of mechanical stresses was also determined to have another implication: Once coated with aluminum, wafers must not be subjected to protracted storage before heat treatment. This is because the relaxation of mechanical stresses leads to the formation of chips even at temperatures below the temperature at

which the aluminum was sputtered. The studies performed further led the authors to conclude that the best method of suppressing recrystallization of aluminum films is to stabilize the films by subsequent deposition of a heat-resistant coating at room temperature. The best method of doing this appears to be to apply silicon nitride coatings under conditions of a high-frequency discharge at 298 K. Figures 4; references 23: 10 Russian, 13 Western.

#### **Formation of Oxide Films During Initiation of the Decomposition of Metal Carboxylates by Pulsed Laser Radiation**

927M00551 Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 9, Sep 91 (manuscript received 23 Mar 90; after revision 13 Sep 90) pp 132-136

[Article by V.S. Aksenov, A.P. Belikov, V.D. Borman, and A.V. Khmelev, Moscow Physics Engineering Institute]

UDC 621.793.7

[Abstract] The authors of the study reported herein worked to establish the possibility of forming highly adherent films of such materials as CuO, ZrO<sub>2</sub>, U<sub>3</sub>O<sub>8</sub>, and Y-Ba-Cu-O by pulsed laser vaporization of organometallic compounds from a substrate, decomposition of

the compounds in the vapor phase, and deposition of the resultant metal oxides onto a substrate surface that has been locally expanded by radiation. Carbonic acid salts (the carboxylates Cu, Y, Ba, Zr, and U) were applied from a liquid solution onto a substrate (Mo, Cu, ZrO<sub>2</sub>, or BeO) surface by vaporization in a vacuum and then subjected to pulsed laser radiation (using a Kvant-15 laser) with a wavelength of 1.06  $\mu\text{m}$ , beam radius of 0.025 cm, and pulse duration of  $4 \times 10^{-3}$  s in air, argon, and N<sub>2</sub>. The experiments performed confirmed that it is indeed possible to locally apply pulsed radiation to a substrate with an applied layer of difficultly volatile organometallic compound in order to modify the substrate's surface. Such modification is possible thanks to initiation of processes of vaporization of the organometallic compound, heating of the vapors by the mechanism of heat conduction and resonance absorption, vapor-phase decomposition of the organometallic compound, oxidation of the hydrocarbon products, deposition of the metal oxides, and fusion of the near-surface layers of the substrate. Formation of oxide films characterized by a strong adhesion was thus demonstrated to only be possible when the oxide molecules interact with the melt of the near-surface layers. The carbon (hydrocarbon) content in the film was shown to be significantly reduced when the reaction is conducted in oxygen and when the gas-phase hydrocarbon molecules undergo oxidation and form CO and CO<sub>2</sub>. Figures 1, table 1; references 7: 6 Russian, 1 Western.

**Photoinduced Reactions of Organic Compounds  
With Transition Metal Complexes. XVIII.  
Oxidation of Saturated and Alkyl Aromatic  $\text{CrO}_3$   
Compounds in Acetonitrile During Irradiation**

927M00380 Leningrad ZHURNAL OBSHCHEY  
KHIMII in Russian Vol 61 No 3, Mar 91 (manuscript  
received 10 May 89) pp 754-755

[Article by G.B. Shulpin and M.M. Kats, Chemical  
Physics Institute, USSR Academy of Sciences, Moscow]

UDC 541.145.542.943:547.53

[Abstract] In a previous publication, the authors demonstrated that when Cr (VI) oxo compounds are irradiated with light, they are capable of oxidizing saturated and alkyl aryl hydrocarbons. The present article studies the possibility of stoichiometric photooxidation of saturated and alkyl aryl hydrocarbons in a neutral aprotic medium. The authors used acetonitrile as a solvent. Cyclohexane and ethylbenzene and toluene and styrene were used as substrates. Ethylbenzene in the amount of 0.47 mol/l was oxidized to acetophenone and 1-phenylethanol by using a solution of  $\text{CrO}_3$  ( $2.5 \times 10^{-3}$

mol/l) coupled with irradiation with full light by a high-pressure mercury lamp. After 6 hours of irradiation the solution became nontransparent, and acetophenone and 1-phenylethanol were obtained with respective yields of 53 and 11% (as calculated for  $\text{CrO}_3$ ). The reaction also took place in the dark; however, it proceeded extremely slowly. Moreover, the amount of 1-phenylethanol produced was so slight that it could not even be determined. Changing the  $\text{CrO}_3$  concentration did not significantly increase the reaction rate. At high ethylbenzene concentrations, the speed of the reaction was virtually independent of the ethylbenzene concentration. Under the same conditions, cyclohexane produced a mixture of cyclohexanone and cyclohexanol. Oxidation of cyclohexane to  $\text{CH}_3\text{CN}$  did not occur in the dark. Under the effect of light,  $\text{CrO}_3$  oxidized to adipic acid in  $\text{CH}_3\text{COOH}$ . Toluene and styrene resulted in much lower yields of benzaldehyde as the sole reaction product. The authors thus succeeded in demonstrating that photooxidation of hydrocarbons by chromium trioxide in acetonitrile is a convenient method of soft oxygenation of saturated and alkyl aromatic hydrocarbons. References 4 (Russian).

**New Process for Recovering Oil Refining Gases**

927M0039A Moscow *KHIMIYA I TEKHOLOGIYA TOPLIV I MASEL* in Russian No 7, Jul 91 pp 3-4

[Article by F.R. Ismagilov, S.A. Moiseyev, O.K. Malandin, S.R. Khayrullin, and K.P. Kuzmenkov, Bashkir Special Technological Design, Grozneftkhim Scientific Production Association Office; Catalysis Institute, Siberian Department, USSR Academy of Sciences, and Tuapse Oil Refinery]

UDC 665.632.074.341

[Abstract] The Catalysis Institute of the Siberian Department of the USSR Academy of Sciences and the Bashkir Special Technological Design Office of the Grozneftkhim Scientific Production Association have jointly developed a process for cleaning hydrogen sulfide-containing hydrocarbon gases. The process results in the formation of elemental sulfur by direct single-stage oxidation of hydrogen sulfide by the oxygen in air in a fluidized bed of IK-12-72 aluminum-magnesium-chromium catalyst. The catalyst was developed by the Catalysis Institute and has been produced in an experimental batch in accordance with specification TU 6-09-5505-88. The catalyst features a high mechanical crushing strength (18.5 to 20 MN/m<sup>2</sup>) and low evaporation rate (0.55%/min), and the amount of catalyst depleted in the catalysis unit per day does not exceed 0.5%. The catalyst has a granular density of 800 to 1,200 kg/m<sup>3</sup> and a granule size of 1.4 to 2 mm. The Bashkir Special Technological Design Office developed all of the off-standard equipment required for the new process. Unlike the Claus process, the new process makes it possible to scrub gases even in the presence of sizable hydrogen sulfide content fluctuations. It is, for example, efficient in scrubbing the low-sulfur (up to 1.5%) gases from direct oil distillation that are usually dumped into an oil refinery's fuel system without preliminary scrubbing. The technology used in the new process was developed at the Tuapse Oil Refinery on a pilot installation with a raw material (hydrocarbon fuel gas) capacity of 50 m<sup>3</sup>/h. The new process includes provisions to divert the process oxidation products (sulfur and reaction moisture vapors in a mixture with hydrocarbons) to a recovery boiler, where they are condensed. The liquid sulfur is drained to a steam-heated sulfur tank. The scrubbed gas passes to an economizer-condenser that is filled with Raschig rings and sprinkled with water from above to rinse off the particles of entrained sulfur and catalyst. After this step, the scrubbed gas is sent on to the fuel system. The process is controlled from an operator's panel. The new process has been proved to be efficient and ecologically pure. A pilot unit to clean fuel gas at a rate of 2,000 m<sup>3</sup>/h is slated for design and construction at the Tuapse Oil Refinery. The new process equipment is more compact than the Claus process equipment, requires less metal to manufacture, and provides a higher degree (98-99%) of sulfur extraction from fuel gases. Figures 4.

**Oxidized Low-Molecular Polyethylene as a Cutting Fluid Compound**

927M0039B Moscow *KHIMIYA I TEKHOLOGIYA TOPLIV I MASEL* in Russian No 7, Jul 91 pp 5-6

[Article by A.V. Shiychuk and D.V. Kolesnikova, Chernovitsy State University and Lvov Polytechnic Institute]

UDC 678.742.2:541.128:661.125:621.56

[Abstract] The authors of the study reported herein examined the tribotechnical properties and surface activity of carbonic acid soaps produced by liquid-phase oxidation of low-molecular mass polyethylene. Their purpose in so doing was to use the said polyethylenes to create cutting fluids. Low-molecular mass polyethylenes with an initial molecular mass of 3.5 kg/mol were oxidized by technical-grade oxygen in the presence of a catalyst. Two specimens of low-molecular mass polyethylenes with different depths of oxidation were studied. Specimen 1 consisted nearly solely of monocarbonic acids. Specimen 2 also contained a certain amount of dicarbonic acids, which form as a result of the secondary oxidation of long-chain monocarbonic acids. The first specimen had an acid number of 72.7 mg KOH/mg, a mean-numerical molecular mass of 0.8 kg/mol, and a mean-numerical functionality indicator of 1.04. The second specimen had respective values of 189 mg KOH/g, 0.4 kg/mol, and 1.35 for the same indicators. In the low-concentration range, the surface activity of a soap of oxidized low-molecular mass polyethylene turned out to be somewhat higher than that of potassium decanoate. As the concentration increases, however, the surface activity decreases markedly, and a reverse law is observed. The low-molecular mass polyethylenes were also characterized by a low surface stress, which is a most important characteristic of cutting fluids used in metal working. The studies performed confirmed that soap solutions of oxidized low-molecular mass polyethylene in concentrations of 0.5 to 10% exhibit adequate anti-galling properties: Specimen 1 was found to have a critical load of 1,500 N, a bonding load of 2,660 N, and a galling index of 79.0, whereas specimen 2 was found to have a critical load of 1,120 N, a bonding load of 2,000 N, and a galling index of 61.0. A cutting fluid compound based on low-molecular mass polyethylene has passed performance tests on a 2K52-1 radial drilling machine and has been recommended as cutting fluid components. Figures 2; references 6 (Russian).

**Using Microbial Fat in Production of Plastic Lubricants**

927M0039C Moscow *KHIMIYA I TEKHOLOGIYA TOPLIV I MASEL* in Russian No 7, Jul 91 pp 6-7

[Article by M.B. Nakonechanaya, I.V. Lendel, G.G. Mnishchenko, and Yu.Ye. Kazantsev, MASMA Scientific Production Association]

UDC 665.765-404.9:621.892.261

[Abstract] The authors of the study reported herein examined the feasibility of using microbial fat synthesized at the All-Union Scientific Research Institute of Protein Synthesis as a replacement for the plant and food fats currently used in the production of plastic lubricants. The microbial fat studied contains the following: phospholipids; mono-, di-, and triglycerides; free fatty acids; waxes; and unsaponifiable substances. The fatty acid compound consists primarily of normally structured  $C_{14}$ - $C_{18}$  acids, with mono- and diunsaturated acids accounting for 50%. The microbial acid was studied from the standpoint of its suitability as a saponifiable component of lithium and calcium plastic lubricants. Type litol-24 lubricant and type solidol Zh hydrated calcium lubricants served as the study objects. The soap used in the studies was produced from cotton oil, hydrogenated fat, technical-grade 12-HoSt, and microbial fat. The authors attempted to produce six different plastic lubricants. Vaseline oil was used as a dispersing medium in the first three, and a mixture of highly purified I-20A and MS-20 oils was used in the second three. They were unable to produce lubricants by using vaseline oil or the 12-HoSt. They were able to produce two lubricants from microbial fat (containing 20 and 25% saponifiable component, respectively) with the I-20 and MS-20 oil mixture. The lubricants were inferior to lubricants based on hydrogenated fat: The new lubricants had a rubbery texture that persisted even after homogenization. The soap based on microbial fat was also inferior from the standpoint of its thickening ability. The experiments performed thus led the researchers to conclude that although it is possible in principle to produce lithium and calcium lubricants from microbial fat, the results are less than desirable. They did note, however, that using purer oils did improve the new soaps' thickening ability. Tables 3; references 2 (Russian).

#### Hydrocatalytic Refining of Gasoline Fractions of Sulfur Dioxide Condensates

927M0039D Moscow KHIMIYA I TEKHOLOGIYA  
TOPLIV I MASEL in Russian No 7, Jul 91 pp 8-9

[Article by A.F. Akhmetov, R.M. Usmanov, M.N. Akhmetshina, S.Ya. Nelkenbaum, and A.A. Kamenskiy, Ufa Petroleum Institute, Ufa Oil Refinery, and Novokuybyshev affiliate, All-Union Scientific Research Institute of Organic Synthesis]

UDC 665.656.2:66.095.217.3.001.5

[Abstract] The elevated content of sulfur compounds and comparatively low content of naphthene hydrocarbons in condensate from the Karachaganak deposit reduce the value of the gasoline fractions of the said condensate as a raw material for catalytic reforming. In an effort to surmount this problem, the Ufa Oil Refinery tested the feasibility of mixing Western Siberian oils (a mixture of 85-180°C fractions) with the prehydrofined gasoline fraction of Karachaganak condensate. The

respective oils were mixed in ratios ranging from 60:40 to 70:30 and were run through an L-35-5 unit. After a 25-day run, the unit had to be shut down because the octane number of the gas produced dropped by 1-2 points and because the hydrogen content increased by 20%. An attempt was then made to subject the broad gasoline fraction to hydrocatalytic refining by using KD-3P catalyst, which possesses hydroisomerizing properties. This was done on a pilot continuous-type unit with a reactor that had a usable space of 100 ml. The effect of temperature and raw material space velocity on the yield and octane number of the catalysate was studied at a pressure of 3 MPa and a hydrogen feed rate of  $800 \text{ m}^3/\text{m}^3$  raw material. Depending on the given experiment conditions, the motor octane number of the starting gasoline fraction rose from 48 to 70-78 without tetraethyl lead [TEL] or to 80-86 with TEL. The octane number of the catalysate increased as the temperature was increased and as the space velocity of the raw material was decreased. At a raw material space velocity of  $5 \text{ h}^{-1}$ , the maximum catalysate yield at 300°C amounted to 81%; at 320°C, it amounted to 71.64%. The motor octane numbers of the respective catalysates were 70.8 and 75.6. The hydrocarbon gas yields amounted to 15-33% depending on the process conditions. They consisted of 57-60% propane and 28-33% butane. The studies thus confirmed that subjecting Karachaganak gasoline fractions to hydrocatalytic refining with KD-3P catalyst results in high-octane gasoline with a rather high (71 to 80%) yield without catalytic reforming. Figures 2, tables 2; references 2 (Russian).

#### The Effect of Pressure on Properties of Catalysts for Selective Hydrogenation of Reformates

927M0039E Moscow KHIMIYA I TEKHOLOGIYA  
TOPLIV I MASEL in Russian No 7, Jul 91 pp 9-10

[Article by L.V. Shcherbakov, V.B. Maryshev, Yu.A. Skipin, and B.M. Shterman, Lennftekhim Scientific Production Association and Permnefteorgsintez Production Association]

UDC 665.644.5.013

[Abstract] The authors of the study reported herein examined the benefits of cleaning reformates at reduced pressures. During the first phase of the study, a type 35-8 unit was run for 10 days in a boosted regimen. As the temperature in the reforming unit was raised, the pressure was reduced from 1.5 to 1 MPa. A third compressor was connected to keep the hydrogen-containing gas circulating at a high rate. A worsening of the hydrogenation process indicators was noted and attributed to a decrease in the partial hydrogen pressure and an increase in the concentration of olefin hydrocarbons in the reformat as a result of the boosting. The bromine number of the reformat before hydrogenation increased from 2 to 3 g  $\text{Br}_2/100 \text{ g}$  and from 0.8 to 1.1 g  $\text{Br}_2/100 \text{ g}$  after hydrogenation. This in turn increased the amount of impurities in the extraction products, especially in the toluene. No



loss of aromatic hydrocarbons due to hydrogenation was observed. The protracted trial run under unfavorable conditions also resulted in a decrease in catalyst stability. Restoration of the initial reforming regimen resulted in the restoration of the cleaning indicators. The process pressure data were refined under laboratory conditions by using an aluminum-platinum catalyst and a starting material having a constant makeup (i.e., a mixture of hexane-1, benzene, and n-octane in a 1:2:2 ratio by mass). As expected, reducing the process pressure from 1.5 to 1.0 MPa reduced catalyst activity in both the target and side reactions. Altering the pressure affected each of the two types of reactions differently. Catalyst activity in hydrogenation of the double bond was reduced by 10% (relative), whereas it was reduced by 85% (relative) in hydrogenation of the aromatic ring. Thus, after a reduction in pressure, the selectivity of the competing reactions changes in favor of hydrogenation of the olefin hydrocarbons. In other words, the process selectivity increases. The studies thus confirmed that cleaning reformates under low pressure requires a catalyst with an elevated hydrogenating activity and less rigid selectivity requirements. The researchers then attempted to accomplish this by combined loading of two catalysts with different hydrogenation activities, i.e., by using aluminum-platinum catalysts with different platinum contents. They discovered that as more AP-15 catalyst is replaced by AP-64, the hydrogenating activity of the mixture in the target reaction gradually increases. Using up to 10% (by mass) AP-64 catalyst has virtually no effect on hydrogenation selectivity. When the catalyst content reaches 20% (by mass), hydrogenation selectivity increases by 10%, while hydrogenating activity in the target reaction increases by a factor of 1.3. These results were used as a basis for altering the regimen of type L-35-8 units. Using a mechanical mixture of the catalysts AP-15 and AP-64 made it possible to reduce the pressure in the system by 0.2 to 0.3 MPa without any deterioration of the reformat cleaning indicators. This combined loading regimen has been used successfully for 4 years. Figures 2, table 1; references 7 (Russian).

#### Improving the Quality of Base Oils Made From Baku Oils

927M0039F Moscow *KHIMIYA I TEKHOLOGIYA TOPLIV I MASEL* in Russian No 7, Jul 91 pp 10-12

[Article by F.I. Samedova, F.R. Shirinov, T.S. Mamedova, R.B. Kuliyeu, and I.K. Veliyev, Petrochemical Processes Institute imeni Yu.G. Mamedaliyev, AzSSR Academy of Sciences]

UDC 665.637.6.092.5

[Abstract] The motor oils produced from Baku oils have satisfactory antioxidation properties. Their low viscosity index (70-75 for low-paraffin oils and up to 85 for paraffin oils) does not meet the established viscosity index requirements for motor oils, however. Basic

research performed at the Petrochemical Processes Institute imeni Yu.G. Mamedaliyev has shown that the viscosity and temperature properties of motor oil fractions of such oils may be improved by changing the structure of their hydrocarbons. This article reports the results of research on the hydrocarbon modification of motor oil fractions and their raffinates made of a commercial mixture of Baku low-paraffin oils. The ultimate objective of the research was to produce base oils with a viscosity index of at least 90. The physicochemical characteristics of the oil mixture were as follows: viscosity, 7.85 mm<sup>2</sup>/s at 50°C; density, 881 kg/m<sup>3</sup> at 20°C; cokability, 1.67% (by mass); coagulation point, -40°C; and respective sulfur, tar, and paraffin contents, 0.34, 6.43, and 4.4% (by mass). Motor oil fractions of the said mixture with viscosities corresponding to I-20 and I-40 industrial oils and MS-20 residual oil were subjected to hydrofining. Motor oil components were obtained from the distillates and detarred residue by three techniques entailing different combinations of selective refining, hydrofining, and hydrocarbon modification. Conventional refining of distillates of the oils I-20 and I-40 and deasphaltation resulted in oils with a viscosity index between 80 and 88. Hydromodification of the oil fractions of a mixture of raffinates of I-20 and I-40 oils before selective refining resulted in base oils with a viscosity index between 86 and 92. The greatest increase in viscosity index was achieved by hydrocarbon modification of the motor oil fraction raffinates. When a mixture of raffinates of I-20 and I-40 oils was subjected to selective refining followed by hydrocarbon modification, its viscosity index increased to 97. The possibility of improving the viscosity and temperature properties of commercial motor oils was then investigated by way of the example of raffinate of D-11 commercial oil distillate. Hydromodification of the raffinate under the aforesaid conditions resulted in an oil with a viscosity index of 90. The Baku Oil Refinery imeni 22d CPSU Congress has since been able to produce oil with a viscosity index of 95-97 by using the said process. Tables 3; references 4 (Russian).

#### The Effect of an Emulsifier on the Properties of Fire-Resistant Pressure Fluid

927M0039G Moscow *KHIMIYA I TEKHOLOGIYA TOPLIV I MASEL* in Russian No 7, Jul 91 pp 28-29

[Article by V.G. Bedenko, T.N. Nichikova, B.Ye. Chistyakov, and L.N. Lapshina, All-Union Scientific Research Institute of Surfactants]

UDC 661.185+665.765+532.695

[Abstract] Oil-soluble surfactants (for example, esters of multiatomic alcohols and fatty acids) are generally used as emulsifiers in the production of water-in-oil emulsions. The sedimentation resistance of such emulsions in the case of moderate concentrations of the disperse phase is too low; consequently, the water drops in the



emulsion adhere to one another and form rapidly sedimenting aggregates. In an effort to overcome this problem, the authors of the study reported herein examined the effect that the makeup of an emulsifier containing a mixture of water- and oil-soluble surfactants has on the colloid chemistry properties of emulsion pressure fluids based on the oil I-12A. S-5A succinimide was used as the oil-soluble surfactant. The nonionogenic surfactant DS-10 sintanol [Synthenol] was used as the water-soluble component of the emulsifier. The study emulsion of water in I-12A oil was produced by mixing at a speed of  $83 \text{ s}^{-1}$  for 20 minutes. Different ratios of S-5A and DS-10 were tested. The minimum water drip size in the emulsion and the maximal sedimentation resistance were both achieved in the case of S-5A and DS-10 concentrations of 1.2 and 0.4% (by mass), respectively. The numerical concentration of drops in an emulsion containing 1.4% (by mass) S-5A and 0.2% (by mass) DS-10 changed only in the first 5 to 10 days of storage. After that time, coalescence of the drops virtually halted. The studies performed demonstrated that using a mixture of S-5A water-soluble succinimide and DS-10 water-soluble sintanol as an emulsifier results in finely dispersed emulsion pressure fluids that are characterized by good sedimentation and coalescence resistance. The emulsion pressure fluids produced also manifested a low frothability. Figures 2; references 8 (Russian).

#### The Radiation and Heat Stability of the Components of High-Temperature Oils and Working Fluids

927M0039H Moscow KHIMIYA I TEKHOLOGIYA  
TOPLIV I MASEL in Russian No 7, Jul 91 pp 29-30

[Article by N.I. Alekhina, S.Z. Levinson, N.S. Oreshkova, and A.M. Bezhanidze, Elektrogorsk affiliate, All-Union Scientific Research Institute of Oil Refining]

UDC 665.6.085(0.48)

[Abstract] The data on the radiation and heat stability of individual groups of hydrocarbons and compounds are incomplete. Information does exist on the radiation stability of saturated and aromatic hydrocarbons isolated from oil refining products. Corresponding data on paraffins and naphthenes of the high-boiling part of oil are virtually nonexistent, however. The authors of the study reported herein examined the radiation stability of isoparaffin hydrocarbons and concentrates of mono-, bi-, tri-, tetra-, and pentacyclic naphthene hydrocarbons from aromatized oil. The study concentrates were produced by the method of thermodiffusion separation of the saturated portion of the given oil, i.e., groups of hydrocarbons with a specific dispersion of 100 or less. The saturated hydrocarbons studied were isolated by the chromatographic method. The study oil was obtained from slow-coking heavy gas oil by the method of isolating the oil fraction and subsequent selective deparaffinization and adsorption cleaning. Nine fractions were

isolated and studied: The first fraction consisted of virtually pure (97.8%) isoparaffin hydrocarbons, whereas the ninth fraction was a 90% concentrate of tetra-, penta-, and hexacyclic naphthene hydrocarbons. The ninth fraction possessed the highest radiation stability under the study conditions ( $\gamma$ -irradiation at  $200^\circ\text{C}$  in an inert medium). The eighth fraction had approximately the same radiation stability. The seventh fraction, which contained about 50% bi- and tricyclic naphthenes, was somewhat less stable when subjected to  $\gamma$ -radiation. Concentrates of monocyclic naphthene and isoparaffin hydrocarbons were found to possess the lowest radiation and thermal stability. Fraction 8 underwent the least change in kinematic viscosity when subjected to  $\gamma$ -radiation. The viscosity of fractions 2 through 7 increased significantly (by 100 to 200%) following  $\gamma$ -irradiation, whereas the viscosity of fraction 1 actually decreased somewhat. From a radiation stability standpoint, isoparaffins were found to occupy an intermediate position between concentrates of tetra-, penta-, and hexacyclic condensed naphthenes at the top end of the radiation stability scale and mono- and bicyclic naphthene hydrocarbons at the bottom end. The stability of concentrates of saturated hydrocarbons isolated from oil was nearly an order of magnitude below that of the starting oil and that of the aromatic hydrocarbons with a specific dispersion of  $>160$  that are included in it. Tables 2; references 6 (Russian).

#### Calculating the Element Profile of the Organic Portion of Solid Mineral Fuels

927M0042A Moscow KHIMIYA TVERDOGO  
TOPLIVA in Russian No 4, Jul-Aug 91 (manuscript  
received 19 Apr 90) pp 21-23

[Article by M.Ya. Shpirt, N.N. Ignatova, and T.G. Archakova, Mineral Fuels Institute]

UDC 662.66:543.83

[Abstract] Solving certain coal chemistry problems requires estimating the indicator characterizing the content of organic matter (O) and the related content of inorganic components (M). Because there is no direct method of determining the organic mass content of solid mineral fuels, the obvious relationship  $O = 100 - M$  is used. It is generally assumed that the organic mass of solid mineral fuels contains carbon, hydrogen, nitrogen, oxygen, and sulfur. The authors of this article have estimated the relative errors occurring when the carbon, hydrogen, nitrogen, sulfur, and oxygen contents in the organic mass of solid mineral fuels are calculated based on the assumption that the amount of mineral matter in coals and their ash content are equal to one another. They demonstrate that as the ash content of a given mineral fuel increases, there is a sharp lowering of the values obtained for the fuel's carbon, hydrogen, sulfur, and nitrogen contents and a sharp elevation of the oxygen content. This is shown to be especially true in the case of anthracites. The authors present a table detailing

the mean values of the element (carbon, hydrogen, nitrogen, and sulfur) content of lignite, bituminous coal, and anthracites as a function of their ash content. The relative errors in determining the element content of the organic mass of solid mineral fuels as a function of ash content are also presented in table form. Figure 1, tables 2; reference 1 (Russian).

### Effect of the Polyassociativity of the Structure of the Organic Mass of Coal on Its Yield of Fluid Products

927M0042B Moscow KHIMIYA TVERDOGO  
TOPLIVA in Russian No 4, Jul-Aug 91 (manuscript  
received 10 Aug 90) pp 24-31

[Article by S.G. Gagarin and T.G. Gladun, Mineral Fuels Institute]

UDC 539.107:641.442:662.7:681.142

[Abstract] The authors propose a model of the polyassociative structure of coals that is intended for use in developing a quantitative description of the yield of fluid products under conditions of thermal processes in a centrifugal field. They demonstrate that in the case of coals in a low stage of metamorphism, it is heteroatomic centers that play the primary role during self-dissociation of structure. In the case of coals in a high stage of metamorphism, on the other hand, it is the interaction between aromatic fragments that predominates. The yield of fluid products is shown to reach a maximum when the role of self-dissociation of the given coal's structure is at a minimum. The authors acknowledge that their two-parameter model is simplified inasmuch as it only describes the main trends in the change in the polyassociativity of the organic mass of coal during the metamorphism process. They further acknowledge that this may result in a discrepancy between experimentally obtained data and data calculated by using their model on account of factors not given consideration when the model was developed. Specifically, they state that their attribution of the output of fluid products to sintering components is only an approximation. They further caution that the distribution of a given coal's microcomponents may also affect the results obtained. Finally, they admit that the characteristics of equally metamorphosed coals may differ depending on their degree of oxidation or reduction and that further research is needed to be able to incorporate the effects of these factors into their proposed model. Information on the properties of coals of the Kuznetsk Basin and a comparison of the sinterability of coals from the Kuznetsk Basin as a function of fraction density are presented in table form. Figures 5, tables 2; references 24: 23 Russian, 1 Western.

### Using Salty Coal From the Novomoskovsk Deposit

927M0042C Moscow KHIMIYA TVERDOGO  
TOPLIVA in Russian No 4, Jul-Aug 91 (manuscript  
received 31 May 90) pp 31-35

[Article by V.F. Levchenko and L.M. Maradudina, Machine Science Problems Institute, UkSSR Academy of Sciences]

UDC 662.61

[Abstract] The study reported herein was conducted to assess the possibility of gasifying the salty coals of the Novomoskovsk deposit by using pulsed electric discharges in water. The new method, which was developed at the Machine Building Problems Institute, is based on the effect of electric current pulses on coal particles in water. The said pulses induce an anomalously high current density in the microsegments of the coal's contact surfaces and heat them to temperatures on the order of 2,727 to 3,727°C. The rate of temperature increase reaches  $10^4$  to  $10^6$ °C/s. This rapid heating causes two things to happen: It induces heat stresses in the coal's layer structure, and it results in an intensive formation of volatile matter in the bulk of the heated portion of the coal that in turn causes the coal's macromolecules to split into chemically active fragments with the velocity of a thermal explosion. Because the process occurs in water, these active high-temperature fragments of dispersed coal enter into chemical reactions with the water vapors and form synthesis gas. Processing coal in water in this manner results in the gasification of 40 to 60% of the carbon. The remaining coal forms a water-and-coal suspension containing up to 70% carbon with an average particle size of tens of microns. The proposed process was tested on salty coal from the Novomoskovsk deposit (which contains about 12% sodium oxide in its ash). The process was implemented in an electric discharge reactor. Coal particles 5 to 8 mm in size were loaded between the reactor's graphite electrodes, and water was pumped through. The voltage at the reactor's electrodes ranged from 400 to 600 V, the current ranged from 0.5 to 2 kA, the pulse duration ranged from 30 to 40  $\mu$ s, and the frequency was varied from 100 to 1500 Hz. The test reactor was distinguished by the nonstationary operating mode of its core, in which the energy feed rate was significantly faster than the rate at which heat was abstracted from the contact regions. The pulse mode of supplying power made it possible to maintain mean mass temperatures of 40 to 60°C in the reactor while implementing the process. The tests performed confirmed that the method of using pulsed electric discharges in water is in principle possible for processing salty coals. Tables 3; references 5: 4 Russian, 1 Western.

**The Change in the Direction of the Mechanical-Chemical Transformations of Lignite Upon Dispersion When a Catalyst Is Present**

927M0042D Moscow KHIMIYA TVERDOGO  
TOPLIVA in Russian No 4, Jul-Aug 91 (manuscript  
received 2 Mar 90) pp 50-54

[Article by T.M. Khrenkova, V.B. Rubinchik, and V.S. Kirda, Mineral Fuels Institute]

UDC 662.550.41

[Abstract] Experiments have shown that adding a catalyst when breaking up lignite in a hydrogen medium changes the direction of the mechanical and chemical transformations involved in the breakup. This catalyst-induced change is in the direction of mechanically destructive hydrogenation. The breakup products turn out have a lower aromaticity than the starting coal does, and they have a higher content of  $\text{CH}_2$  groups. The indicator of the reaction of the hydrogenation of condensed aromatic hydrocarbons, i.e.,  $\text{CH}_2/\text{C}_{\text{ar cond}}$ , decreases as the breakup time is increased (while the hydrogen pressure is kept constant). The process of breaking up coal in a hydrogen medium is distinguished by the evolution of propane into the gaseous phase and by an increased methane content. These phenomena confirm that the breakup of coal with a catalyst at room temperature in a hydrogen medium entails transformations associated with mechanically destructive hydrogenation, including the opening of the six-membered naphthene rings and their destruction along with evolution of propane. The relative fraction of the specified reactions increases as the breakup time is increased. A study of the aforesaid breakup process revealed that mechanical working of the said coal in a paste-forming medium activates its donor capability. The presence of a catalyst in the system accelerates the mechanical activation process of the transfer of hydrogen from the paste-forming agent to the coal. These conclusions are confirmed by the following experiment results. Lignite with an atomic hydrogen:carbon [i.e.,  $(\text{H/C})_{\text{at}}$ ] ratio of 0.84-0.85 was broken up in a vibratory mill to which a paste-forming agent with an  $(\text{H/C})_{\text{at}}$  of 1.70 had also been added. After 10 minutes, the  $(\text{H/C})_{\text{at}}$  ratio of the coal increased to 0.89, and that of the paste-forming agent decreased to 1.65. When the process was repeated with the addition of a catalyst, the  $(\text{H/C})_{\text{at}}$  ratio of the paste-forming agent dropped to 1.48, while that of the coal increased to 0.90. When the coal was broken up in a paste-forming agent in a hydrogen medium, the  $(\text{H/C})_{\text{at}}$  ratio of the coal remained virtually unchanged, whereas the  $(\text{H/C})_{\text{at}}$  ratio of the paste-forming agent equaled 1.64. These data were taken as confirmation of the fact that when coal is broken up in a hydrogen medium, the paste-forming agent does not function as a hydrogen donor in relation to the coal. When hydrogen gas and a catalyst are both present, it is molecular hydrogen rather than the hydrogen of the paste-forming agent that is the main source of stabilization of the mechanical-chemical transformation products. Tables 5; references 3 (Russian).

**The Change in the Pore Structure of Ekibastuz Weakly Sintered and Podmoskovsk Brown Coals During the Process of Their Heat Treatment**

927M0042E Moscow KHIMIYA TVERDOGO  
TOPLIVA in Russian No 4, Jul-Aug 91 (manuscript  
received 1 Mar 90) pp 57-61

[Article by A.A. Anishchenko, I.L. Golenko, A.Yu. Maystrenko, V.N. Ogiy, and T.N. Khandros, Energy Conservation Problems Institute, UkSSR Academy of Sciences]

UDC 62.405.8+662.74

[Abstract] The authors of the study reported herein examined the changes that occur in the pore structure of Ekibastuz and Podmoskovsk coals and their cokes when they are subjected to heat treatment. Methods based on water vapor adsorption and the thermal desorption of argon were used to determine the specific surface. A technique based on the sorption of water vapors and benzene while the partial adsorbate pressure was kept close to the pressure of the saturated vapors was used to determine pore sorption volume. Total pore volume was determined from the difference of the apparent and actual densities. The study specimens were subjected to rapid ( $10^5$  K/s) and slow (8 to 10 K/s) pyrolysis in an inert atmosphere in the range of temperatures from 873 to 1,323 K. The pyrolysis was conducted on an experimental unit for heat-treating and burning fuels in a flowing and fluidized bed. This made it possible to feed solid fuel particles into the reactor at a specified temperature within several seconds in the case of slow heating and within 0.05 s in the case of rapid heating. The studies demonstrated that the pore structures of the study coals undergo different changes under the effect of pyrolysis. The heating rate during pyrolysis also has different effects on the pore structure of each of the study coals. Both rapid and slow pyrolysis were found to result in the development of a pore structure in the Ekibastuz coal. In other words, both pyrolysis regimens resulted in an increase in the Ekibastuz coal's specific surface and pore volume. In the case of slow pyrolysis, however, a temperature up to 1,223 K did not exert any significant effect on surface area or pore volume in water. Rapid pyrolysis caused extreme changes in both surface area and pore volume. The studies confirmed that in the case of Ekibastuz coal, the best pore structures are obtained by slow pyrolysis in the temperature range from 1,023 to 1,123 K. Slow pyrolysis at temperatures between 923 and 1,123 K was demonstrated to be best for Podmoskovsk lignite. Preliminary pyrolysis was found to result in an increase in surface and micropore volume in the case of Ekibastuz coal and in the development of transport pores in the case of Podmoskovsk lignite. Figures 2, table 1; references 7: 6 Russian, 1 Western.

**The Effect of Methanol on the Liquefaction of Coals in the Presence of Various Catalysts**

927M0042F Moscow KHIMIYA TVERDOGO  
TOPLIVA in Russian No 4, Jul-Aug 91 (manuscript  
received 20 Jun 89) pp 96-103

[Article by P.N. Kuznetsov, Ya. Bimer, and P.D. Salbut, Chemistry and Chemical Technology Institute, Siberian

Department, USSR Academy of Sciences, and Organic Chemistry Institute, Warsaw]

UDC 662.75

[Abstract] The authors present data from their study of the liquefaction of various coals in methanol in the presence of a broad set of catalysts, including sodium and calcium hydroxides and carbonates and transition metal chlorides and hydroxides. Coals in different stages of metamorphism from deposits in Poland and the USSR were subjected to liquefaction in the presence of various catalysts in amounts ranging from 1 to 10% of the coal treated. The liquefaction was conducted in 0.25- and 2-l autoclaves at temperatures of 350, 380, and 430°C. Processing the coals in an autoclave in a methanol medium in the presence of NaOH was found to result in a product containing less oxygen and more hydrogen than the starting coal. The resultant product was capable of dissolution in organic solvents. The studies revealed that in the presence of NaOH, the H/C ratio does not depend on the amount of methanol present. Solubility in  $\text{CHCl}_3$  in the absence or presence of only low concentrations of catalyst was found to increase as the methanol content increased. In the presence of high concentrations of NaOH, the solubility of the study coal at 350°C amounted to more than 70% and remained virtually unchanged as the amount of methanol was varied within the bounds from 100 to 300 ml. When Ni, Co, Fe, Zn, Sn, Mo, and hydrogen chlorides and hydroxide were present under elevated pressures, the use of methanol generally had a weak effect on the liquefaction product's solubility in benzene. The effect of various factors on the alkylating and hydrogen-donor properties of methanol was also examined. The effect of methanol during the hydrogenation of coal was found to depend on the type of catalyst used; the degree of methylation of maltenes at 380°C varied between 14 and 25% depending on the catalyst used. A sequence of five reactions entailed in the methylation and liquefaction of coal was diagrammed and discussed. The researchers observed significant differences between the degree of alkylation of aromatic substances formed during the effect of methanol on brown coal and during its direct action on model individual hydrocarbons and coal maltenes. This fact was interpreted as an indication of the fact that it is not the end products of liquefaction that are subjected to alkylation but rather (more likely) intermediate reactive particles formed during the heat destruction of the organic mass of coal. In view of the fact that alkylation products of not only liquids but also solid insoluble coal fragments are observed after the liquefaction of coal in alcohols, the authors further hypothesized that the alkylated mass of coal undergoes liquefaction. In other words, they concluded that alkylation likely precedes the stage in which liquid substances are formed. The authors took this fact as an explanation for the absence of any dependence of the degree of alkylation on process temperature and duration. Figures 4, tables 3; references 36: 10 Russian, 26 Western.

### Carbon Construction Materials in Nuclear Engineering

927M0042G Moscow *KHIMIYA TVERDOGO TOPLIVA* in Russian No 4, Jul-Aug 91 (manuscript received 20 Jun 89) pp 119-129

[Article by Yu.S. Virgilyev and Ye.I. Kurolenkin,

UDC 621.039.532.21

[Abstract] The authors present data on the radiation resistance of various carbon construction materials within the range of irradiation temperatures extending from 340 to 1,700 K and at fluences up to  $2 \times 10^{22}$  neutrons/cm<sup>2</sup> ( $E \geq 0.18$  MeV). They demonstrate that carbon construction materials with prespecified properties for use in nuclear engineering within a broad range of working conditions may be created by altering the crystalline structure, supermolecular organization, intergrain interaction, and type of carbon components used in the starting carbon material. Specifically, graphite may be rendered more resistant to the adverse effects of irradiation by reducing the degree of perfection of its crystalline structure, for example, by heat treatment below 2,600 K. Another way of strengthening and improving the radiation resistance of reactor-type graphites is to subject them to additional sand impregnation in the intermediate product formation stage and to then heat-treat them. Sealing graphite blanks in the intermediate or finished product formation stage by using poorly graphitized carbon impregnates will result in a dense material that actually consists of two carbon phases with different degrees of ordering of their crystalline structures. Each of these phases will then make its own contribution to the construction material's overall size stability in the face of irradiation. Replacing the conventional binder material, i.e., coal tar, with pyrolytic carbon will strengthen grain boundaries and make it possible to achieve construction materials with physical properties that are noticeably better than those of conventional reactor graphite. Achieving the best possible adhesion between binder and filler and increasing filler dispersivity will also help form stronger structural bonds between filler grains and thereby produce construction materials that are more resistant to the effects of radiation. Creating materials with a homogenous structure (specifically, pyrolytic carbons) will also result in increased radiation stability. The strength properties and isotropy of pyrolytic carbons can also be increased by catalytic deposition of carbon onto a heated base. Controlling the processing temperature within the range from 1,500 to 3,100 K will also significantly improve both the absolute value of shape alteration and its rate of onset. Refractory compounds such as borides, nitrides, and carbides (including silicon-alloyed graphites) are among the most promising construction materials for use in nuclear engineering. Heat and crack resistance are among the most important factors to consider when selecting materials to function under high temperatures and mechanical loads. Graphite's crack resistance



increases after low-temperature (320 to 340 K) irradiation. This effect diminishes as the irradiation temperature is increased but still remains above zero. Irradiation does accelerate the corrosion of graphite; however, the effect of irradiation on corrosion rate diminishes as temperature is increased. Because radiation-induced shape alteration has a tendency to decrease at temperatures above 1,500 to 1,600 K, graphite may be used under high-temperature conditions. Figures 8, tables 2; references 18 (Russian).

#### **Polycyclic Aromatic Hydrocarbons of Middle Fraction 200- 400°C Crude**

927M0048A Moscow NEFTEKHIMIYA in Russian  
Vol 31, No 4, Jul-Aug 91 (manuscript received  
26 Dec 90) pp 439- 451

[Article by I. A. Matveyeva, M. I. Bekauri, A. Yu. Kolesnikov, and Al. A. Petrov, Geology and Exploitation of Fuel Minerals Institute, Moscow]

UDC552.578.2

[Abstract] Lately a clear interest has been evidenced in the scientific literature concerning polycyclic hydrocarbons having two or more aromatic rings and in the 200-400°C boiling point range. This type of hydrocarbon includes four homologous series: naphthalenes, diphenyls, fluorenes, and phenanthrenes. Primary members, as well as methyl, dimethyl, and even trimethyl homologs of these series have been determined in crudes. These hydrocarbons attracted attention because the ratio of certain of their isomers is frequently used as an indicator of regressive evolution (catagenesis) of crude oil. These transformations are based on the circumstance that  $\alpha$ -methyl(dimethyl) structures, present in unconverted crudes, are converted to  $\beta$ -methyl(dimethyl) substituted hydrocarbons during regressive evolution. In the present work a method was developed to determine methyl-dimethyl and certain trimethyl substituted hydrocarbons of the above four homologous series in the 200- 400°C fraction of crudes. Several methyl- and dimethyl substituted hydrocarbons of the diphenyl, fluorene, and phenanthrene series were synthesized. Chromato-mass spectrometry and mass-chromatography were used on crudes from Teleti deposit to determine up to 70 C<sub>10</sub>-C<sub>16</sub> hydrocarbons. The possibility of evaluating the composition catagenic change in crudes on the basis of hydrocarbon distribution was demonstrated. Figures 2; references 18: 9 Russian, 9 Western.

#### **Polycyclic Aromatic Hydrocarbons From Middle Fractions of Crudes From Different Origins**

927M0048B Moscow NEFTEKHIMIYA in Russian  
Vol 31, No 4, Jul-Aug 91 (manuscript received  
20 Jan 91) pp 452- 459

[Article by A. Yu. Kolesnikov, I. A. Matveyeva, M. I. Bekauri, and Al. A. Petrov, Geology and Exploitation Fuel Minerals, Moscow]

UDC547.52:552.578.2:665.61

[Abstract] In a previous report [cf. 927M0048A] a method was described for identifying polycyclic arenes in the middle fraction of Teleti (Georgia) crudes. In the present work polycyclic aromatic hydrocarbons from other oil and gas regions are examined. Study of crudes having various origins is required owing to the sparsity of information on the effects of genetic and evolutionary factors on the relative distribution of polycyclic hydrocarbons. Specifically, the structure and relative distribution of alkyl-substituted naphthalenes, diphenyls, fluorenes, and phenanthrenes in the 200-400°C fractions were investigated. The results demonstrated that the relative distribution of the above is nearly the same in all crudes studied. Possible routes for the formation of bi- and tri-cyclic arenes are presented. Formation of these hydrocarbons from saturated hydrocarbons of 200-400°C cut was confirmed experimentally. Figure 1; references 10: 3 Russian, 7 Western.

#### **Acid-Catalytic Breakdown of Resin-Asphaltenic Compounds in Crudes**

927M0048C Moscow NEFTEKHIMIYA in Russian  
Vol 31, No 4, Jul-Aug 91 (manuscript received  
28 Nov 90) pp 471- 474

[Article by V. S. Yeliseyev and I. U. Nutanov, Chemistry Institute imeni V. I. Nikitina, Dushanbe]

UDC665.17

[Abstract] Various chemical additives and catalysts are used to accelerate the oxidation of petrochemical feedstock and to improve the properties of the products. However, the chemical action of these additives on individual components of the products have not been thoroughly investigated. It was previously demonstrated that boiling benzene solutions of asphaltenes in the presence of AlCl<sub>3</sub> breaks them down to form low molecular weight and condensation products. It is also known that certain organic sulfo- and nitro-compounds may also participate in the breakdown, similar to that of oxygen. In the present work results are presented on the breakdown of resin-asphaltenic compounds with dilute mineral, organic, and Lewis acids acting as catalysts. The breakdown results in the formation of low molecular weight acid products and high molecular weight aromatic products. In the presence of catalysts, the resin-asphaltenic compounds dealkylate to form condensation products having hybrid structure. References 5 (Russian).

#### **Polycyclic Aromatic Radicals in High Boiling Point Crude Oil Hydrocarbons and Their Thermal Stability**

927M0048I Moscow NEFTEKHIMIYA in Russian  
Vol 31, No 4, Jul-Aug 91 (manuscript received  
12 Jul 90) pp 528- 531

[Article by M. I. Rustamov, V. R. Mardukhayev, and A. P. Mamedov, Petrochemical Processing Institute imeni Yu. G. Mamedaliyeva, Baku]

UDC665.61+665.7:543.422.27

[Abstract] Crude oil and its products have a paramagnetism caused by the presence of resin-asphaltene substances and complexes of transition metal ions. It is also assumed that the thermodestruction of heavy crude bottoms stock takes place according to a radical-chain mechanism, although the paramagnetism associated with the radicals taking part in these processes, have not yet been detected. It was previously reported that thermally generated free radicals of a hydrocarbon character have been observed in heavy crude bottoms stock. EPR spectra indicated that the observed radicals are unique, i.e. with the large diversity of organic substances in crude oil, only a single type of hydrocarbon is responsible for the formation of the radical. However the available experimental data did not permit making any conclusions on the structure of the observed paramagnetic particle, its thermal stability, or the effects of atmospheric oxygen upon it. In the present work further analysis of the EPR spectra of these free radicals demonstrated that they are derived from methylperinaphthane. These radical are generated at 40-140° C and perish at higher temperatures, without formation of paramagnetic particles if under vacuum, and with formation of resin-asphaltene structures if heated in air. Figures 2; references 8 (Russian).

#### Dearomatization of Middle Distillates to Produce Ecologically Clean Diesel Fuel

927M0048J Moscow NEFTEKHIMIYA in Russian  
Vol 31, No 4, Jul-Aug 91 (manuscript received  
5 Oct 90) pp 570- 573

[Article by V. M. Kurzanov, V. A. Khavkin, A. N. Zenchenkov, and L. N. Osipov, Petroleum Refining SRI (A-U), Moscow]

UDC665.61(574):665.61.03

[Abstract] For the purpose of improving air quality in densely populated areas, both the sulfur and aromatic hydrocarbon contents in diesel fuels must be reduced. The latter may be achieved by catalytic hydrogenation of the aromatic hydrocarbons present in middle distillates. In the present work a study was made of the simultaneous dearomatization and desulfurization of these distillates. Two basic types of catalyst studied were sulfide (oxide) and metallic palladium. Sulfur and nitrogen compounds were observed to have a poisoning effect on the palladium catalysts. Preliminary upgrading of the initial crude is recommended. References 4 (Russian).

#### Slow-Coking Gasolines—A Raw Material for Producing Hydrocarbon Gases

927M0052A Moscow KHIMIYA I TEKHOLOGIYA  
TOPLIV I MASEL in Russian No 9, Sep 91 pp 2-3

[Article by A.Z. Dorogochinskiy, V.G. Karakashev, and N.V. Shirokova, Grozno Petroleum Institute imeni Academician M.D. Millionshchikov]

UDC 665.656.097.3:661.183.6

[Abstract] The authors of the study reported herein worked to develop a process of using slow-coking gasolines as a raw material for producing hydrocarbon gases. During the study, slow-coking gasolines were transformed into C<sub>2</sub>-C<sub>4</sub> olefin and aromatic hydrocarbons on high-silica zeolite-containing catalysts. The experiments were performed on an integrated-type straight-through reactor at a temperature of 550 to 650°C with between 0.25 and 0.5 mm catalyst. The tests were conducted for 30 minutes, and the catalyst was regenerated (i.e., subjected to oxidizing regeneration at 550°C) for periods of 120 minutes. The experiments revealed that heat-and-vapor treatment of the high-silica zeolite-containing catalyst used resulted in significant alterations in both its activity and selectivity. Between 20 and 40 minutes of the said heat-and-vapor treatment proved best in improving the catalyst's activity and selectivity for transformation of the slow-coking gasoline into primarily C<sub>2</sub>-C<sub>4</sub> olefin hydrocarbons. The total yield of C<sub>2</sub>-C<sub>4</sub> olefin and aromatic hydrocarbons was comparable to their yield in the process of pyrolysis of straight-run gasoline fractions; however, they are obtained at a lower temperature. In addition, the composition of the gas olefins produced in the process of transformation of slow-coking gasolines on a heat-and-vapor-treated high-silica zeolite-containing catalyst is characterized by an elevated propylene and butene content but not by an elevated ethylene content as is the case during the pyrolysis process. The formation of C<sub>2</sub>-C<sub>4</sub> olefins thus predominates in the process of treating slow-coking gasolines with the aforesaid zeolite-containing catalyst. Figures 2, table 1; references 5 (Russian).

#### Light Catalytic Cracking Gas Oil as a Component of Diesel Fuel

927M0052B Moscow KHIMIYA I TEKHOLOGIYA  
TOPLIV I MASEL in Russian No 9, Sep 91 pp 3-4

[Article by T.N. Mitusova, I.Ya. Perezhigina, B.A. Englin, L.N. Shabalina, A.M. Senekina, V.A. Stankevich, and A.A. Makarov, All-Union Scientific Research Institute of Oil Refining, Moscow Oil Refinery, and State Chemistry Scientific Research Institute]

UDC 665.644.2

[Abstract] At the present time in the USSR, 46% of all light catalytic cracking gas oils are used as a component of summer diesel fuel after hydrofining in a mixture with straight-run diesel fuel. Another 10% is used as a component of home furnace fuel, 13% is used in F-5 marine mazout, and 31% is used in furnace mazout. Since the introduction of G-43-107 units, which use hydrofined vacuum distillate as their starting material, it has become possible to use light catalytic cracking gas oils as a component of commercial diesel fuel without additional hydrofining. In view of this fact, the authors of the study reported herein examined the possibility of using light catalytic cracking gas oil as a component of diesel



fuel. They prepared 10, 20, and 30% light catalytic cracking gas oils for the G-43-107 unit at the Moscow Oil refinery. The cetane number and density turned out to be the limiting quality indicators when adding light catalytic cracking gas oils to base fuel. Specifically, when the cetane number equals at least 45 and the density does not exceed  $860 \text{ kg/m}^3$ , up to 25% light catalytic cracking gas oils may be used. Tests performed on mixtures of diesel fuel containing up to 25% light catalytic cracking gas oil produced in a G-43-107 unit fully meet the requirements established in GOST 305-82 for summer diesel fuel. From an oxidation resistance and thermal-oxidative stability standpoint, however, the proposed fuel remains inferior to straight-run diesel fuel. New stabilizing and antioxidation additives will need to be developed to solve this problem because the existing analogous additives intended for use in automotive gasolines and rocket fuels have proved to be ineffective in diesel fuels. Figure 1, tables 2; references 5 (Russian).

#### **Solid Fuel Mineral Resins as Components of Motor Oil Corrosion Inhibitors**

927M0052C Moscow *KHIMIYA I TEKHOLOGIYA TOPLIV I MASEL in Russian No 9, Sep 91 pp 3-5*

[Article by I.V. Klimyuk, S.V. Zubko, A.B. Englin, G.B. Shirokova, and M.D. Bayramukova (deceased), State Chemistry Scientific Research Institute, Peat Institute, BSSR Academy of Sciences, All-Union Scientific Research Institute of Oil Refining, and Leningrad Economics and Engineering Institute imeni P. Tolyatti]

UDC 630.3:620.193.91

[Abstract] Corrosion-proofing lubricating materials play an important role in fighting the corrosion and mechanical wear of metal products, and water-soluble corrosion inhibitors are largely responsible for their effectiveness. Commercial production of the fairly new (less than 10 years old) motor oil corrosion inhibitors NG-107M and NG-110M, etc., is being held up due to a shortage of the oil refining products used in them. In an effort to remedy this situation, the authors of the study reported herein examined the feasibility of using resins of solid fuel minerals as components of the said motor oil corrosion inhibitors. Specifically, they tested lignite wax resin and the alcohol-soluble and -insoluble portions part of peat wax resin. Each of the three resins was tested to determine its drop point, wax and resin content, and other key indicators. The medium and heavy fractions of shale tar were also tested. As expected, the two shale tar fractions had the highest stability. Tests of all five candidate corrosion inhibitor components yielded positive results. The medium- and heavy-fraction shale tars were effective in removing corrosive electrolyte from metal surfaces, and the lignite and peat wax resins proved effective in protecting metal surfaces under conditions of corrosive media (when metal test products were placed in an  $\text{SO}_2$  atmosphere or were fully immersed in artificial sea water). None of the resins tested had any

significant effect on the fundamental performance properties of the motor oils to which they were added. From the standpoints of solubility in motor oils, physical stability of the resultant solutions, and protective and basic performance properties, the resins may therefore be recommended as components of combination corrosion-inhibiting motor oil additives. In order of moderating corrosion-inhibiting effect, the five resins tested may be ranked as follows: heavy- and medium-fraction shale tar  $\rightarrow$  alcohol-insoluble peat wax resin  $\rightarrow$  alcohol-soluble peat wax resin  $\rightarrow$  lignite wax resin. Figures 2, tables 4; references 7 (Russian).

#### **Corrosion-Proofing Oil To Protect Metal Against Corrosion**

927M0052D Moscow *KHIMIYA I TEKHOLOGIYA TOPLIV I MASEL in Russian No 9, Sep 91 pp 7-8*

[Article by A.A. Gureyev, I.A. Timokhin, and N.V. Zubkova, MING (not further identified) imeni I.M. Gubkin]

UDC 620.197.3

[Abstract] The authors of the study reported herein have examined a new corrosion-proofing oil that has been developed based on a mixture of nitrated and transformer oils. The new oil was intended to equal the service performance of K-17, another widely used corrosion-proofing oil. Both oils protect steel in a mineralized acid medium; however, K-17 does not protect steel subjected to the corrosion action of diluted sulfuric acid. For this reason, the developers of the new corrosion-proofing oil worked to make it effective in protecting metal against diluted sulfuric acid. They tested various additives, namely, SZhK  $\text{C}_{10}\text{-C}_{16}$  diethanolamide, the neonols AF-9-4 and AF-9-12, and the sintanol [transliteration] DS-10, added in 1 to 2% (by mass) concentrations. The tests conducted demonstrated that the surfactant neonol AF-9-4 will, when added in the amount of 2% (by mass), significantly improve the degree of protection provided by corrosion-proofing oils under conditions involving the effects of diluted sulfuric acid. The said surfactant will not reduce the protective effects of the new nitrated and transformer oil-based oil, nor will it worsen that new oil's physicochemical properties. The new oil may be used to protect machine building products against corrosion along with the oil K-17. The new oil is comparable to K-17 from the standpoint of protective properties and is actually superior to it in an acid medium. Figures 2, tables 2; references 2 (Russian).

#### **Methyl-tert-Butyl Ether as a Component of Aircraft Gasolines**

927M0052E Moscow *KHIMIYA I TEKHOLOGIYA TOPLIV I MASEL in Russian No 9, Sep 91 pp 12-13*

[Article by V.Ye. Yemelyanov, P.S. Deyneko, Ye.A. Nikitina, and V.P. Grebenshchikov, All-Union Oil Refining Scientific Research Institute]

UDC 62.631.2:629.113

[Abstract] Two types of aviation gasoline are produced in accordance with All-Union State Standard [GOST] 1012-72, namely, B-91/115 and B-95/130. Of the two gasolines, B-91/115 accounts for more than 99% of the aviation gasoline used. It is produced from catalytic reforming gasoline (55-60%) plus alkylbenzene (35-40%) and toluene. In view of the shortage of the latter two compounds, the authors of the study reported herein examined the feasibility of using methyl-tert-butyl ether [MTBE] as a component of aviation gasolines. When added to B-91/115 aviation gasoline, MTBE resulted in a much greater increase in octane number than did adding alkylbenzene or toluene. MTBE also proved to be superior from an antidetonation effectiveness standpoint. Adding 8% MTBE provided the same increase in gasoline rating as did adding 15% toluene or 30% alkylbenzene. The high antidetonation effectiveness of MTBE was explained in terms of a reduction in the heat stress of the aircraft engine's components as the gasoline burned. The studies thus confirmed the fundamental feasibility of using MTBE as a component to replace toluene and alkylbenzene in commercial aviation gasolines. Figure 1, tables 3.

#### Dewatering Fuels in a Spray Absorber

927M0052F Moscow KHIMIYA I TEKHOLOGIYA  
TOPLIV I MASEL in Russian No 9, Sep 91 pp 14-15

[Article by V.L. Zhrebtsov, O.A. Merkulov, M.M. Peganova, and T.V. Timofeyeva, State Institute of Applied Chemistry Scientific Production Association]

UDC 662.75:66.021.3

[Abstract] The authors of the study reported herein examined the possibility of dewatering hydrocarbon solvents and kerosene-type fuels in an experimental unit with a Venturi absorber. The experimental unit included an absorber that was serially connected to a hydrocyclone. The unit operates as follows: Nitrogen gas enters the cylindrical part of the absorber from a tank through a reducing gear and valve. At the same time, a hydrocarbon liquid that is sprayed at the same speed as the gas flow enters the absorber's confusor. Intensive mass transfer in the system liquid-nitrogen-dissolved water-air takes place in the nozzle (diffusor-confusor) portion of the absorber. As a result, the liquid becomes saturated with nitrogen, and water and oxygen are desorbed from it. In the diffusor, the gas flow-sprayed liquid slows down and enters the hydrocyclone, where it is separated into gas and liquid. When the substances undergoing dewatering are toxic, the unit may be made to operate in a closed-loop cycle. Tests conducted on a pilot model of the new spray absorber-based dewatering unit (designed for a liquid flow rate of 0.002 to 0.006 kg/s) confirmed its effectiveness. Tests conducted on a full-scale model of the new spray absorber installed in an automobile demonstrated that the new unit has a virtually unlimited

capacity that is determined solely by the space constraints imposed regarding the absorber's size and the required product-filling time. The proposed unit offers several advantages over conventional dewatering schemes: It provides a high mass transfer intensity and does not require as much space as conventional units do. The tests performed thus confirmed that parallel-flow absorbers are indeed feasible for use in dewatering and nitrating gasolines, kerosenes, and diesel fuels. Figures 2; references 5 (Russian).

#### The Effect of Oil With the Additive MKF-18 on the Wear Resistance of Friction Couples

927M0052G Moscow KHIMIYA I TEKHOLOGIYA  
TOPLIV I MASEL in Russian No 9, Sep 91 pp 15-16

[Article by E.B. Ivankina, N.G. Kozhayeva, S.V. Obratsov, I.A. Gavrilova, Ye.G. Makhovkin, and S.V. Ledyayev, Kuybyshev affiliate, All-Union Scientific Research Institute of Oil Refining]

UDC 665.765.404.038:621.89

[Abstract] The authors of the study reported herein examined the effects that using the additive MKF-18 in industrial oil would have on reducing the wear resistance of friction couples. The additive MKF-18 (produced in accordance with specification TU 38 101127-87) is a 50% concentrate of an organic copper compound in the oil I-20A. To test its role in boosting the lubricating properties of industrial oil, it was compared with the conventional additive DF-11 (i.e., zinc dialkyldithiophosphate, which is produced in accordance with All-Union State Standard 24216-80). To compare the two additives, the researchers mechanically mixed 0.6% (by mass) MKF-18 and 1 and 2% (by mass) DF-11 with industrial oils of the series IGP, ISP, and IRp. The oil mixtures were compared as to their effectiveness in reducing wear in the friction couples of three different pieces of machinery (a vibratory friction gauge and frontal friction and four-ball testing machines. The friction couples tested were made up of the following types of steel: 40Kh-45, 20Kh-35, and ShKh15-ShKh15. Each friction couple was subjected to friction loads for a period of 5 minutes (amplitude, 1 mm; vibration frequency, 50 Hz) at temperatures not exceeding 45°C. Under small loads (up to 300 N), the MKF-18 additive proved superior to DF-11. In the case of the frontal friction machine, however, the DF-11 appeared to reduce wear to a greater extent than the MKF-18 did. Mixing the two additives together produced a synergistic effect: the improvements in the antiwear and antifriction properties of the base industrial oil derived from using a combination of MKF-18 and DF-11 were greater than those resulting from using either additive alone. MKF-18 could not, based on the tests conducted, be said to eliminate wear in the friction couples tested. Classifying MKF-18 as a metal-cladding additive would require additional metallographic studies. The tests did indicate,

however, that MKF-18 is advisable for use at comparatively low per-unit-area pressures. Combined use of MKF-18 and DF-11 should also be considered. Figures 4, table 1; references 7 (Russian).

**The Effect of Temperature on the Viscosity and Pressure of Saturated Vacuum Oil Vapors**

927M0052H Moscow *KHIMIYA I TEKHOLOGIYA TOPLIV I MASEL in Russian No 9, Sep 91 pp 17-18*

[Article by I.N. Buneyev, A.A. Gureyev, M.I. Falkovich, and V.T. Solodovnikova, MING (not further identified) imeni I.M. Gubkin]

UDC 665.765-404.033

[Abstract] As part of an effort to find promising new materials to use as raw materials for the production of vacuum oils, the authors of the study reported herein examined the effect of temperature on the viscosity and pressure of saturated vacuum oil vapors. Specifically, they examined seven mineral-based vacuum oils (VM-1, VM-1S, VM-5, VM-5S, VM-6, VM-4, and VM-3), the synthetic organosilicon fluid FM-21, and polyphenyl ether (n-PPE). The effect of temperature on the degree of association of the molecules of each of the said vacuum oils was calculated along with other parameters characterizing the oils (refractive index at 293 K, density at 293 K, molecular mass, and viscosity at 323 K). The studies performed indicated the following patterns. At temperatures above 373 K, the molecules of the vacuum oils enter a nonassociated state with a constant free energy of viscous friction activation. The dependence between specific volume  $1/\rho$  and fluidity  $1/\eta$  of the oils may be described by A.I. Bachinskiy's linear equation for nonassociated liquids, which confirms that the oils remain in a nonassociated state at the normal operating temperatures of vacuum pumps. At temperatures below 373 K, the viscosity-temperature curve of vacuum oils is described by an equation with three constants, and the free energy of the activation of a viscous friction diminishes smoothly as the temperature increases. At temperatures above 373 K, the free energy of viscous flow activation remains constant and equals about one-fourth the vaporization heat. In other words, the most important performance characteristics of vacuum oils, i.e., saturated vapor pressure and viscosity, change with temperature in a virtually proportional manner. Figures 3, tables 2; references : Russian, Western.

**Oils of the Yakutsk ASSR**

927M0052I Moscow *KHIMIYA I TEKHOLOGIYA TOPLIV I MASEL in Russian No 9, Sep 91 pp 24-26*

[Article by S.G. Khabibullin, L.Z. Garipova, A.A. Voltsov, and F.M. Kasimova, Bashkir Scientific Research Institute of Oil Refining]

UDC 665.61.03

[Abstract] A number of high-sulfur oil deposits have been studied in the vicinities of the cities of Mirny and Lensk in the Yakutsk ASSR. The oil is located in the following beds: Sredne-Botubinskoye, Verkhne-Vilyuchanskoye, Irelyakhskoye, Tsentralno-Talakanskoye, and Tas-Yuryakhskoye. These beds are characterized by anomalously low seam temperatures (8 to 14.5°C) and pressures (9.4 to 15.8 MPa). Their gas factor does not exceed 100 m<sup>3</sup>/t. This article presents four lengthy tables detailing the physicochemical characteristics of oils sampled from different depths throughout the beds. The broad gasoline fractions contain from 0.03 to 0.12% sulfur and have a low octane number (38 to 42 according to the motor method). The greatest naphthene hydrocarbon content (18 to 24.5%) was noted in the fractions boiling at temperatures between 62 and 95(100)°C. In higher-boiling fractions, their content was reduced to 6.5-10%. The kerosene fractions sampled do not meet the requirements set for jet fuel; they are inferior from the standpoints of density, crystallization initiation temperature, and content of mercaptan sulfur compounds. The diesel fuel fractions have a high diesel index and a cetane number between 45 and 47. The vacuum distillates (350-450 and 350-500°C) are distinguished by their high content of paraffin-naphthene hydrocarbons (52-65%) and low cokability (not exceeding 0.2%) and are a good raw material for catalytic cracking. The Yakutsk deposits are all in hard-to-reach places with a severe climate, and transporting the oils from the deposits to oil refineries is very difficult. Because all of the oil in the area is of one type, oils from the different beds may be mixed in any ratio. Local refining of the oil to meet local needs for motor and fuel oils is a possible option, as is constructing a system of small-capacity oil refineries in the cities of Mirny and Lensk. Tables 4.

**The Use of High-Silica Zeolites To Scrub Sulfur Compounds From Gases**

927M0052J Moscow *KHIMIYA I TEKHOLOGIYA TOPLIV I MASEL in Russian No 9, Sep 91 pp 37-38*

[Article by N.P. Moreva, Z.K. Olenina, Yu.P. Yasyan, A.Yu. Adzhiyev, All-Union Scientific Research and Design Institute of Gas Refining]

UDC 66.074.7

[Abstract] The authors of the study reported herein examined the possibility of using a number of high-silica zeolites scrub sulfur compounds from gases. Specifically, they examined the ability of the following high-silica and general-purpose zeolites to adsorb hydrocarbon sulfoxides: TsVM-TM-146, TsVM-TB-451, TsVM-TM-537, TsVM-TB-456(Shch), NTsVM-TB-333+339(0.05), NTsVM-TB-333+339(0.1), NTsVM-TM-146(1), NTsVM-TM-146(5), TsVK-TM-1475, CaA-1277, NaX-1232, and NaX. The adsorption of hydrocarbon sulfoxide (in initial concentrations of 1 to 1.1 g/m<sup>3</sup>) on the

said zeolites was studied under dynamic conditions at a temperature of 25°C and linear velocity of 0.25 m/s at atmospheric pressure with a sorbent charge of 6 cm<sup>3</sup>. Each specimen was first regenerated in a helium current at 300°C for 3 hours and then helium-cooled to 25°C. Of the general-purpose zeolites, CaA was found to have a good ability to adsorb hydrocarbon sulfoxide. All of the hydrocarbon high-silica zeolites with the exception of TsVK-TM-1475 and NTsVM-TM-146(5) demonstrated a higher activity than did CaA. Their dynamic capacity ranged from 2.65 to 3.4 g/100 g. The following relationship was observed for four TsVM specimens from different batches: the zeolites's capacity decreased as its content of Na<sub>2</sub>O increased. A very different picture emerged in the case of the starting and H-forms of the

high-silica zeolites of the batch TM-146: the specimen's activity decreased as its Na<sub>2</sub>O content increased (in other words, as the degree of exchange of sodium cations with hydrogen ions increased). Because mercaptans accompany hydrocarbon sulfoxide in both natural and oil gas, the researchers tested a combination of TsVM-TB-451 and NTsVM-TB-333+339(0.1) zeolites with a model mixture containing both hydrocarbon sulfoxide and ethyl mercaptan. As the mixture's ethyl mercaptan content increased, the sorbents' ability to absorb hydrocarbon sulfoxide decreased markedly. The data obtained confirmed the promise of using high-silica zeolites as adsorbents for use in scrubbing sulfur compounds (especially hydrocarbon sulfoxide and mercaptans) from gas flows. Figures 2, tables 2; references 2 (Russian).

### Synthesis and Physicochemical Investigation of $\text{UO}_2\text{SO}_3 \cdot (\text{CH}_3)_2\text{SO} \cdot \text{H}_2\text{O}$

927M0045A Leningrad *RADIOKHIMIYA* in Russian  
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3 Jan 90) pp 9-11

[Article by V.A. Blatov and V.N. Serezhkin]

UDC 548.736

[Abstract] One complex of uranyl sulfite with dimethyl sulfoxide [DMSO], namely  $\text{UO}_2\text{SO}_3 \cdot 2\text{DMSO} \cdot 0.5\text{H}_2\text{O}$  (I), has been reported in the literature. It has not, however, been characterized by roentgenography. In view of this fact the authors of the study reported herein synthesized the compound  $\text{UO}_2\text{SO}_3 \cdot (\text{CH}_3)_2\text{SO} \cdot \text{H}_2\text{O}$  and subjected it to roentgenographic analysis. The researchers were unable to synthesize monocrystals of the  $\text{UO}_2\text{SO}_3 \cdot (\text{CH}_3)_2\text{SO} \cdot \text{H}_2\text{O}$  suitable for x-ray crystallographic analysis. By using a DVK-3M microcomputer to perform a series of computations based on an automatic indication program, the researchers were, however, able to calculate the following parameters for an elementary monoclinic cell of compound  $\text{UO}_2\text{SO}_3 \cdot (\text{CH}_3)_2\text{SO} \cdot \text{H}_2\text{O}$ :  $a = 0.9752(3)$ ,  $b = 0.9009(3)$ , and  $c = 1.1214(5)$  nm;  $\beta = 106.41(2)^\circ$ ; and  $Z = 4$ . The authors were able to demonstrate that compounds I and  $\text{UO}_2\text{SO}_3 \cdot (\text{CH}_3)_2\text{SO} \cdot \text{H}_2\text{O}$  are isostructural. They were further able to demonstrate that  $\text{UO}_2\text{SO}_3 \cdot (\text{CH}_3)_2\text{SO} \cdot \text{H}_2\text{O}$  is characterized by a layered structuring of  $[\text{UO}_2\text{SO}_3 \cdot (\text{CH}_3)_2\text{SO} \cdot \text{H}_2\text{O}]$  complex groupings and belongs to the structural group  $\text{AT}^3\text{M}_2^1$  of uranyl complexes with translocation of  $\text{M}^1$  neutral ligands in the equatorial plane of  $\text{UO}_7$  pentagonal bipyramids. Figure 1, table 1; references 6 (Russian).

### The Radioluminescence of $^{241}\text{Am}^{(\text{III})}$ and $\text{Eu}^{(\text{III})}$ in $\text{Cs}_2\text{NaLuCl}_6$

927M0045A Leningrad *RADIOKHIMIYA* in Russian  
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23 Aug 90) pp 29-32

[Article by Yu.A. Barbanel, V.V. Kolin, and V.P. Kotlin]

UDC 535:37:(546.799.5+546.661)

[Abstract] The authors of the study reported herein examined the photo- and self-luminescence of  $\text{Am}^{(\text{III})}$  in the compound  $\text{Cs}_2\text{NaLu}(\text{Am})\text{Cl}_6$  (10%  $^{241}\text{Am}$ ) and recorded the luminescence of  $\text{Eu}^{(\text{III})}$  in  $\text{Cs}_2\text{NaLu}(\text{Am}, \text{Eu})\text{Cl}_6$  (10%  $\text{Am}$ , 1%  $\text{Eu}$ ) excited by the energy of the  $\alpha$ -decay of americium. The study specimens were produced in the form of cakes formed by solidifying melts with the respective stoichiometric compositions. All spectra recorded during the study were taken with the specimens held in identical positions by specially manufactured sealed holders. The radioluminescence spectra of both  $\text{Am}^{(\text{III})}$  and  $\text{Eu}^{(\text{III})}$  were recorded at 298 and 77 K. The spectra recorded indicated that the radioluminescence of both  $\text{Am}^{(\text{III})}$  and  $\text{Eu}^{(\text{III})}$  is of the f-f transition type. In the case of  $\text{Am}^{(\text{III})}$ , the most intensive transition was

that from  $^5\text{L}_6$  to  $^7\text{F}_0$  (about 520-540 nm). In the case of  $\text{Eu}^{(\text{III})}$ , the most intensive transitions were as follows:  $^5\text{D}_1 \rightarrow ^7\text{F}_2$  (553 nm);  $^5\text{D}_1 \rightarrow ^7\text{F}_2$  (560 nm);  $^5\text{D}_0 \rightarrow ^7\text{F}_1$  (594 nm); and  $^5\text{D}_0 \rightarrow ^7\text{F}_2$  (about 600-630 nm). After analyzing the spectra recorded, the authors hypothesized a resonance and/or nonradiative transfer of light energy from  $\text{Am}^{(\text{III})}$  to  $\text{Eu}^{(\text{III})}$ . Without attempting to explain the mechanism of this process, the authors noted that its initial stage entailed the liberation of nuclear energy during the  $\alpha$ -decay of  $^{241}\text{Am}$ , whereas its final stage entailed the emission of optical photons by  $\text{Eu}^{(\text{III})}$ . The attenuation in the  $^5\text{L}_6 \rightarrow ^7\text{F}_0$  bands of  $\text{Am}^{(\text{III})}$  when  $\text{Eu}^{(\text{III})}$  was added was found to be greater at 298 K than at 77 K. This was hypothesized to be an indication of the increase in the efficiency of  $\text{Am}^{(\text{III})} \rightarrow \text{Eu}^{(\text{III})}$  energy transfer as a result of the extensive absorption of  $\text{Eu}^{(\text{III})}$  due to temperature expansion of the resonating lines and the high likelihood of nonradiative energy transfer involving lattice vibrations. The absence of radioluminescence of  $\text{Eu}^{(\text{III})}$  in  $\text{Cs}_2\text{NaLu}(\text{Cm}, \text{Eu})\text{Cl}_6$  (0.1%  $^{244}\text{Cm}$ ) was interpreted as a confirmation of the hypothesis of the resonance reaction  $\text{Am}^{3+} \rightarrow \text{Eu}^{3+}$ . Figures 2; references 6: 4 Russian, 2 Western.

### Spectra of f-d Transitions of Uranium Triiodide in Organic Solvents in the Presence of Crown Ethers

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26 Mar 90) pp 35-39

[Article by S.A. Kulyukhin, A.N. Kamenskaya, and N.B. Mikheyev]

UDC 541.49+546:791.3

[Abstract] In previous studies the authors of the study reported herein established the fact that adding different macrocyclic ethers to aqueous solutions of uranium (III) does not change the absorption spectra of the f-d transitions of  $\text{U}^{3+}$ . This led them to the conclusion that in aqueous solutions, the large hydration shell of the ion  $\text{U}^{3+}$  prevents direct interaction of cation and ligand. The literature does, however, contain reports regarding the synthesis of tetrahydrofuran of  $\text{UCl}_3$  and  $\text{UI}_3$  complexes with a number of crown ethers from aqueous solutions. No data are available regarding the reaction in organic solvents of uranium in a +3 state of oxidation and these ligands. For this reason, the authors examined the effect that crown ethers exert on the absorption spectra of the f-d transitions of uranium (III). Uranium triiodide synthesized in accordance with a method described elsewhere was used along with solvents (acetonitrile, propylene carbonate, and tetrahydrofuran) that had been subjected to treatment to remove oxidizing agent and water impurities and that had been distilled in an oxygen-free argon current directly before the experiment. The following crown ethers were used: 12-crown-4, 15-crown-5, 18-crown-6, dibenzo-18-crown-6, dicyclohexyl-18-crown-6, diaza-18-crown-6, and dithia-18-crown-6. The absorption spectra were recorded on a



Specord M40 spectrophotometer. The respective solvents were used as comparison solutions. All of the experiments were performed in a dry chamber with an argon atmosphere. Uranium triiodide was found to dissolve rather well in all of the study solvents. Green solutions were found to form in  $\text{CH}_3\text{CN}$ , cherry-red solutions formed in propylene carbonate, and violet solutions formed in tetrahydrofuran. The addition of crown ethers to these solutions resulted in color changes. The formation of slightly soluble complexes in tetrahydrofuran was observed in the case of some of the ligands. The absorption spectra recorded led the authors to conclude that the size of the macrocyclic ring, the presence of different substituents, and the nature of the donor atoms of the crown ethers all affect the change in absorption spectra of the f-d transitions of uranium (III). Specifically, the change in the crown ether's ring size was most apparent in the spectra of  $\text{U}^{3+}$  in the presence of 15-crown-5 in both  $\text{CH}_3\text{CN}$  and propylene carbonate. The researchers also noted a strong splitting of the bands when compared with the spectra of uranium (III) in pure solvents and in the presence of other crown ethers. In the case where different polyhedra had identical ring sizes, adding solvents such as benzo and cyclohexyl groups was also found to alter the absorption spectra of f-d transitions. The use of substituents had a less pronounced, albeit still real effect. Figures 5, table 1; references 17: 10 Russian, 7 Western.

**Investigation of the Sorption of Uranium From Carbonate-Containing Solutions by Inorganic Sorbents. XI. Thermodynamics of Uranium Sorption by the Sorbent Thermoxide-5 in Sorption-Desorption Cycles**

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23 Mar 90) pp 89-92

[Article by A.N. Nuriyev, G.A. Akperov, V.M. Komarevskiy, R.M. Mamedov, and Yu.P. Novikov]

UDC 541.183.5:546.791

[Abstract] The authors of the study reported here examined the thermodynamics of uranium sorption in sorption-desorption cycles. Their primary objective in so doing was to determine the fraction of sorbed uranium that is expended for formation of these irreversibly sorbed surface compounds. The experiments were performed with the sorbent Thermoxide-5 (granule size,  $0.8$  to  $1.0 \times 10^{-2}$  cm). The study reaction was implemented in the temperature range from  $20$  to  $65^\circ\text{C}$  by using various uranium concentrations (from  $2.6$  to  $10^{-5}$  to  $8.4 \times 10^{-4}$  mol/l) in a seawater-type carbonate-containing solution with a pH of  $7.85 \pm 0.05$ . After each sorption cycle, the uranium was subjected to desorption by natural seawater that did not contain uranium. The desorption process was structured as follows: After 8 hours of sorption, the spent uranium solution was carefully decanted, the sorbent was rinsed with distilled water to remove all residue

of the uranium solution, and the solution was then decanted once again. A strip of filter paper was used to blot the sorbent from the surface. Ten milliliters of fresh uranium-free seawater was then added to the sorbent, and the solution was mixed for 1 hour. The solution was decanted, another 10 ml fresh uranium-free seawater was added, and the solution was mixed for another hour. This sorption-desorption cycle was repeated five times (with three desorptions per hour). The  $\alpha$ -radiometry method was used to control the uranium concentration during sorption and desorption. Changes in the entropy, enthalpy, and free energy of the uranium sorption reaction were detected from cycle to cycle. Specifically, the values of the enthalpy and entropy of the uranium sorption reaction were found to diminish from cycle to cycle in a monotonic-linear fashion. Within three to five cycles these values became virtually constant, thus indicating that after three to five cycles, the reaction of uranium sorption becomes essentially a single-state ion exchange process. The studies performed thus led the authors to conclude that the process of uranium sorption-desorption on the sorbent Thermoxide-5 begins as a two-stage process consisting of a reversible ion exchange stage (stage 1) and an irreversible chemisorption stage (stage 2). After the third cycle, the contribution of stage 2 becomes negligible, and the process essentially becomes one of reversible ion exchange. Figures 4, tables 2; references 3: 2 Russian, 1 Western.

**Investigation of the Sorption of Uranium From Carbonate-Containing Solutions by Inorganic Sorbents. XII. Kinetics of Uranium Sorption by the Sorbent Thermoxide-5 in Sorption-Desorption Cycles**

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23 Mar 90) pp 93-95

[Article by A.N. Nuriyev, G.A. Akperov, V.M. Komarevskiy, R.M. Mamedov, and Yu.P. Novikov]

UDC 541.183.5:546.791

[Abstract] In a continuation of their previous research on the sorption of solution from carbonate-containing solutions, the authors of this study examined the kinetic distinctions of the behavior of the sorbent Thermoxide-5 in sorption-desorption cycles. The Thermoxide-5 sorbent had a grain size of  $0.8$  to  $1.0 \times 10^{-2}$  cm. The carbonate-containing uranium solutions were prepared and tagged with  $^{233}\text{U}$  in accordance with procedures published elsewhere. The study experiments were performed in the temperature interval from  $20$  to  $65^\circ\text{C}$  with varying concentrations of uranium in the carbonate-containing solutions. The pH was kept at  $7.85 \pm 0.05$ . Five sorption-desorption cycles were repeated (with three desorptions in 1 hour). The procedures followed in the sorption-desorption cycles were outlined by the authors in their previous communication (Part 11) of



this ongoing study of uranium sorption from carbonate-containing solutions. The experiments performed demonstrated that the activation energy of the sorption process increases with each cycle and becomes constant after three to five cycles, at which time it corresponds to the free activation energy of the irreversible chemisorption process of the reaction of uranium sorption. The authors proceeded to compute generalized rate constants for the chemisorption and ion-exchange stages of the process of uranium sorption by the sorbent Thermoxide-5. Specifically, the rate constants of the ion-exchange reaction for the first through fourth study solutions at 25°C after three to five cycles were found to be between  $2.6 \times 10^{-6}$  and  $2.8 \times 10^{-6} \text{ s}^{-1}$ , respectively. These values are significantly less than the rate constants of the process of uranium sorption for the first sorption cycle, which equal  $3.1 \times 10^{-4}$  and  $1.4 \times 10^{-4} \text{ s}^{-1}$ , respectively, for the first and fourth solutions. These findings were taken as additional confirmation of the fact that after three to five sorption cycles, uranium sorption is primarily an ion-exchange process. Figure 1, table 1; references 3 (Russian).

**The Isolation and Separation of Transplutonium Elements in Unusual Oxidation States by Using Ion Exchangers and Mineral Acid Solutions**

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Vol 33 No 2, Mar-Apr 91 (manuscript received  
4 Dec 89) pp 95-101

[Article by L.I. Guseva, G.S. Tikhomirova, and V.V. Stepushkina]

UDC 544.799

[Abstract] The authors of the study reported herein examined the behavior of transplutonium elements and other actinoids, as well as that of selected fission-fragment elements, on anion and cation exchangers in solutions of  $\text{HNO}_3$ ,  $\text{H}_2\text{SO}_4$ , and  $\text{H}_3\text{PO}_4$  in the presence of oxidizing agents and in  $\text{HCl}$  solutions in the presence of reducing agents. The said elements' behavior was studied as a function of acid concentration, content and nature of the oxidizing (reducing) agent, and type of ion exchanger. Anion exchangers were found to be the most promising ion exchangers for use in isolating transplutonium elements in higher oxidation states. The authors managed to develop effective techniques for separating  $\text{Bk}^{(\text{IV})}$ ,  $\text{Am}^{(\text{VI})}$ , and  $\text{Ma}^{(\text{III})}$  from a large number of other elements by using ion exchangers and mineral acid solutions. Specifically, they demonstrated that anion exchangers may be used to concentrate and separate Bk and Ce from other transplutonium elements and rare earth elements in solutions of  $\text{HNO}_3$ ,  $\text{H}_2\text{SO}_4$ , and  $\text{H}_3\text{PO}_4$  when the acid concentration was kept between 0.1 and 1.0 mol/l with an oxidizing agent present. It was further determined that when Bk is isolated from nitric acid solutions,  $\text{PbO}_2$  should be used as an oxidizing agent. When phosphoric acid solutions are used, on the other hand, good separation is also achieved in the

presence of  $\text{KBrO}_3$ . The greatest  $\text{Bk}^{(\text{IV})}$  selectivity was found to occur in nitric acid solutions, where only a small number of elements (Mo, Tc, Re, Pd, and Au) are sorbed by the anion exchanger. For this reason,  $\text{HNO}_3$  solutions with a concentration of  $< 1 \text{ mol/l}$  are advisable for use in obtaining high-purity Bk preparations. The authors proceeded to use the high sorbability of  $\text{Bk}^{(\text{IV})}$  and  $\text{Ce}^{(\text{IV})}$  by an anion exchanger from mineral acid solutions as a basis for developing chromatographic generators in order to produce pure isotope preparations of  $^{249}\text{Cf}$  and  $^{144}\text{Pr}$  from their respective mother radionuclides  $^{249}\text{Bk}$  and  $^{144}\text{Ce}$ . The studies performed thus confirmed that organic ion exchangers may be used successfully to concentrate and separate transplutonium elements in unusual oxidation states as well as to isolate the said elements from a large number of other elements in mineral acid solutions. Figures 10; references 21: 5 Russian, 16 Western.

**The Possibilities of Using Ion-Exchange Chromatography To Isolate and Study the Physicochemical Properties of Distant Transplutonium Elements**

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Vol 33 No 2, Mar-Apr 91 (manuscript received  
4 Dec 89) pp 101-105

[Article by L.I. Guseva and G.S. Tikhomirova]

UDC 544.799

[Abstract] The authors of this article examined the possibility of using the method of ion-exchange chromatography to isolate and study the physicochemical properties of transplutonium elements with  $Z > 100$ . They did so by way of the example of the study of the ion-exchange behavior of  $^{256}\text{Md}$  and  $\text{Zr}(\text{Hf})$  as an analogue of Ku. Specifically, they assessed the possibility of using new methods of ion-exchange separation of transplutonium elements in different oxidation states with consideration for the factors stabilizing unstable valence forms (including the nature of the oxidizing or reducing agent, the redox potentials of the elements being isolated, the presence of a strong complexing agent, and the nature of the solvent). In the first phase of their research, the authors examined possible cation-exchange systems for separating  $\text{Ku}^{4+}$  from trivalent transplutonium elements and rare earth elements with high purity factors ( $> 10^4$ ) in a regimen of continuous isolation by way of the example of isolating Zr or Hf as analogues of Ku from Cf and Eu. Under static conditions, the authors determined the coefficients of the distribution of Cf, Eu, and Zr between the cation exchanger Dowex-50 and solutions of  $\text{HNO}_3$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{CH}_3\text{COOH}$ , and  $\text{H}_2\text{C}_2\text{O}_4$  in various solvents as a function of acid concentration, nature and content of solvent, presence of the complexing agent trioctylphosphine oxide in  $\text{HNO}_3$  solutions, and the content of divinylbenzene in the resin. In all of the study solutions with the exception of  $\text{HNO}_3$ ,  $\delta/$

trioctylphosphinoxide, the coefficients of the distribution of Cf were several orders of magnitude higher than the distribution coefficients of Zr. This confirmed that such solutions may be used to separate these elements and their analogues on cation exchangers with a high purity coefficient. Water-and-alcohol solutions of phosphoric acid were then used to isolate Zr(Hf) from Cf and Eu on a cation exchange column under conditions simulating the isolation of  $^{261}\text{Ku}$  ( $T_{1/2}$ , 65 s) from an irradiated target. In the next phase of their research, the authors assessed the possibilities of using ion-exchange chromatography to study the physicochemical properties of remote transplutonium elements, identify their valence, states, and estimate their ion radii. They did so by way of the example of an investigation of the ion-exchange behavior of  $\text{Md}^{(II)}$ . They developed the said study method by studying the ion-exchange behavior of  $\text{Eu}^{(III)}$  and other transplutonium elements and rare earth elements along with  $\text{Sr}^{(II)}$  and  $\text{Cs}^{(II)}$  in a combined column with the cation exchanger Dowex-50 or Aminex and Zn(Hg). The studies performed confirmed that ion exchange methods may indeed be used successfully to isolate and study the physicochemical properties of distant transplutonium elements. Figures 2, table 1; references 7: 1 Russian, 6 Western.

#### Effect of Heavy Doses on Radiolysis of Di-2-Ethylhexylsebacinate

927M0049B Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: SERIYA 2, KHIMIYA in Russian Vol 32, No 4, Jul-Aug 91 (manuscript received 18 Jun 90) pp 346-350

[Article by N. S. Oreshkova, V. V. Sarayeva, and M. F. Romantsev, Radiation Chemistry Laboratory]

UDC541.15

[Abstract] High molecular weight aliphatic esters are used widely as base liquids in the production of synthetic lubricants, plasticizers, etc. The development of nuclear technology places high demands on the latter's resistance to radiation. However, information on the conversion kinetics of high molecular weight di-, tri-, and tetra-esters under radiation is missing in the literature. In the present work a study was made of the radiolysis of di-2-ethylhexylsebacinate under vacuum at radiation doses ranging from 0.01 to 1.00 mega-gram-roentgens and 50- 200° using gas chromatography. At high radiation doses and temperatures an increase in the yield of products resulting from molecular fragmentation at the ester and alcohol groups was observed. Figures 3; references 4 (Russian).

#### The Surface Energy of Face-Centered Cubic Lattice Metals

927M0055A Moscow POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA in Russian No 9, Sep 91 (manuscript received 1 Feb 90; after revision 23 Apr 90) pp 5-10

[Article by K.A. Bynkov, V.S. Kim, and V.M. Kuznetsov, Strength Physics and Materials Science Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

UDC 539.211

[Abstract] A method termed the model electron density functional method has been used elsewhere as a way of calculating the thermodynamic properties of simple and transition metals and their alloys. The method, which has resulted in theoretical values that are in good agreement with experimentally obtained data, has been used by the authors of the study reported herein to calculate the surface energy of the face-centered cubic lattice [fcc] metals Ni, Cu, and Al for the surfaces (111), (100), and (110). To calculate surface density ( $\sigma$ ), the researchers used a model of a semi-infinite crystal with a metal-vacuum interface at a temperature of  $T = 0$  K. Surface energy was defined as the energy required for the formation of a unit of surface area to split a crystal into two halves along some atomic plane. Calculations performed by using the model electron density functional method demonstrated that all of the metals examined are characterized by low surface energy anisotropy. Specifically, the following values of  $\sigma(111)$  were found for Ni, Cu, and Al, respectively, (in  $\text{J/m}^2$ : 2.058, 1.746, and 1.054). The magnitude of surface energy was found to increase as surface atom packing decreases. The researchers also found that the surface energy anisotropy of fcc metals is small and virtually identical for all of the metals considered:  $\sigma(111)/\sigma(100) = 0.94$  and  $\sigma(110)/\sigma(100) = 1.08$ . Comparisons of the theoretical results obtained with previously published experimental data revealed that even when no consideration is given to the relaxation of atoms and redistribution of electronic density on the surface of the fcc metal being studied, the model electron density functional method still results in good agreement with existing experimental data. The results obtained by means of the model electron density functional method were also found to be in good agreement with the latest quantum mechanics data published by other authors. The new model electron density functional method was thus demonstrated to be acceptable for use in calculating the surface energy ( $\sigma$ ) of both simple and transition metals. Tables 3; references 28: 12 Russian, 16 Western.

**The Interaction of Surface Acoustic Waves With a Gas Environment at Low Pressure**

927M0055C Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 9, Sep 91 (manuscript received 15 Feb 90; after revision 16 Jun 90) pp 33-39

[Article by O.Ye. Aleksandrov and V.D. Seleznev, Ural Polytechnic Institute, Sverdlovsk]

UDC 533.6.011+534.28-18

[Abstract] The authors examined the interaction of surface acoustic waves with a rarefied gas environment. Unlike in previous studies, the study reported herein gave consideration to the effects of gas adsorption. Specifically, the researchers examined a system gas-solid in which a surface acoustic wave with an oscillation frequency of  $\omega \approx 10^{11}$  Hz or less was excited. They were thus able to assume the solid body to be a continuous medium because the wavelength of the surface acoustic wave  $\lambda$  was many times the period of the lattice. The gas and solid had an identical temperature, and the solid occupied a half-space bounded by a plane along whose surface a plane Rayleigh wave was propagated. The researchers further assumed that the length of the surface acoustic wave's attenuation  $l_{att}$  is much less than the length of the wave ( $l_{att} \gg \lambda$ ). The plane OXZ coincided with the solid body's surface, and the axis OX coincided with the direction of the wave's propagation. The gas was kept under that pressure at which the condition of a free-molecular regimen with respect to the wavelength was met (i.e.,  $\lambda \ll \lambda_f$ , where  $\lambda_f$  designates the free run of molecules in the gas). The state of the gas was described in terms of a two-part molecule distribution function  $f(v, r)$ , with the first part being the distribution function of the molecules flying from the solid body's surface, i.e.,  $f_+(v, r)$  and the second being the distribution function of the molecules striking the surface, i.e.,  $f_-(v, r)$ . The distribution function of the incident molecules was assumed to be a nonperturbed absolutely maxwellian function. The distribution function of the scattered molecules was sought in the form of the power series expansion  $a\omega/c$ . The calculations performed indicated that no fundamental differences exist between the mechanisms of transfer of the energy from surface acoustic waves to gas in free-molecular modes and in viscous modes. The mechanism of pulse transfer to the gas in a free-molecular mode was found to be very different from that in the case of a continuous medium, however. Significant differences were observed between the frequency, mass, and temperature dependences derived for the two modes. The decisive effect of adsorption on the attenuation factor of surface acoustic waves was attributed to gas loading and the rate of entrainment. The studies performed revealed that in a free-molecular mode, surface acoustic waves in a gap appear to act as a separator of the mixture. This separation effect was found to be especially interesting for mixtures of gases with very different absorption times, where the rates of entrainment of the components will differ significantly. Thus, by giving consideration to gas adsorption, the authors were able to

interpret the deviation of the surface acoustic wave attenuation factor  $\gamma$  from the form  $\gamma \approx m^{1/2}$  and the nonlinearity of the frequency dependence of high  $\gamma$  at high (about  $10^9$  Hz or greater) frequencies comparable with an inverse adsorption time. Figure 1; references 6: 5 Russian, 1 Western.

**The Effect of Long-Range Action in the Laser Activation of an Ion-Implanted Dopant in a Silicon Surface Layer**

927M0055E Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 9, Sep 91 (manuscript received 25 Jul 89; after revision 17 Aug 90) pp 53-58

[Article by T.A. Kuzemchenko and S.Yu. Sokolov, General Physics Institute, USSR Academy of Sciences, Moscow]

UDC 535.12.04:621.315.592

[Abstract] The authors of the study reported herein examined the role that long-range action plays in the laser activation of a dopant implanted in a near-surface silicon layer by the technique of ion implantation. The experiments were performed on chemically and mechanically polished type KDB-10 silicon wafers with an orientation of (111), diameters of 60 or 100 mm, and a thickness of 500  $\mu$ m.  $P^+$  ions with an energy of 40 keV were implanted on an ILU-2 ion implantation unit at a dose of  $6 \times 10^{15}$  ions/cm<sup>2</sup> at a current density of  $j = 1 \mu$ A/cm<sup>2</sup>. Irradiation in the said mode was found to result in amorphization of the surface layer of each of the wafers to a depth of about 0.1  $\mu$ m. The implanted layer was annealed by the pulses of a solid-state neodymium-doped glass laser ( $\lambda = 1.06 \mu$ m,  $t_{pulse} = 70$  ns,  $W_e = 1$  J/cm<sup>2</sup>) or a ruby crystal laser ( $\lambda = 0.693 \mu$ m,  $t_{pulse} = 25$  ns,  $W_e = 0.5$  J/cm<sup>2</sup>) in air at atmospheric pressure and room temperature. A sharp boundary demarcating the region of laser annealing had to be established to enable the researchers to study the effect of long-range action, i.e., the nonlocality of the laser effect in the plane of the specimen. This was accomplished by placing a 200- to 300- $\mu$ m-thick copper or duralumin diaphragm with a round opening on the wafer surface and then placing a glass wafer that was matted on two sides above the wafer so as to homogenize the laser radiation and suppress interference effects. An effect of long-range action of the laser effect ( $\lambda = 1.06 \mu$ m) was observed to occur in the form of the formation of a wide (about 1 mm) ring of shallow erosion craters around a region of continuous erosion of the implanted wafer surface extending to an area 5 mm in diameter. The said ring was found to appear against the background of the surface annealed by the same laser ( $\lambda = 1.06 \mu$ m,  $W_e = 1$  J/cm<sup>2</sup>). The distance from the center of the ring to the boundary of the region of continuous erosion (the direct laser effect) amounted to about 1 mm given the specified parameters. Another manifestation of the long-range action of a laser effect was observed upon irradiation of an implanted surface by the ruby laser: a region with a depleted concentration of condensed water

droplets with distinct inner and outer boundaries appeared around the region of the effect (diameter, 2 mm) upon the precipitation of water vapors. The width of this region was observed to increase from 0.1 to about 1.2 mm as the energy density of the laser radiation was increased over the study interval. A third effect of long-range action was discovered, namely, a decrease in the transmission of the sounding radiation ( $\lambda = 10.6$  [sic]  $\mu\text{m}$  of a continuous  $\text{CO}_2$  laser) in the area under the diaphragm. Laser irradiation of wafers that had not been subjected to ion bombardment did not undergo the aforementioned alterations even when the energy density of the laser pulse was sufficient to cause continuous erosion of the monocrystalline surface. The studies demonstrated that regions subjected to direct laser action are obviously sources of intensive phonon fluxes and uneven carriers. They are also sources of static and dynamic thermomechanical stresses on the melt interface that arise during the laser annealing process. Thus, four factors affect the distance from the boundary of direct laser action at which activation of the dopant is observed. These factors are 1) thermal activation, 2) activation by hot electron-donor plasma, 3) shock and acoustic waves, and 4) thermomechanical stresses. Figures 2; references 14: 13 Russian, 1 Western.

#### The Effect of Low-Energy Ion Irradiation on the Atomic Structure of the (100) Surface of the Alloy $\text{CoNi}_3$

927M0055G Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 9, Sep 91 (manuscript received 23 Nov 89; after revision 18 May 90) pp 92-101

[Article by M.A. Vasilyev, S.D. Gorodetskiy, and A.M. Moseychuk, Metallography Institute, UkSSR Academy of Sciences, Kiev]

UDC 537.533.73

[Abstract] The authors of the study reported herein examined the effect of low-energy ion irradiation on the atomic structure of a monocrystal of the alloy  $\text{CoNi}_3$  with its surface oriented parallel to the (100) face. The authors combined the method of low-energy electron diffraction with an original layer-by-layer surface dilatometry technique. A combined low-energy electron diffraction/Auger electron spectrometer equipped with a four-grid quasi-spherical energy analyzer and photometric diffraction reflex-measuring device were used for all study measurements. A special heating system was used to establish the test specimen's temperature in the range from 300 to 1,200 K and to keep it constant with a precision of  $\pm 2$  K. An ion source was used to produce a focused beam with a current density of  $3 \mu\text{A}/\text{cm}^2$  in the energy interval from 0.1 to 1.2 keV. By using spectrally pure argon and continually monitoring its purity by a mass spectrometer and cleaning it by means of a titanium sublimation pump when required, the researchers were able to refrain from introducing foreign atoms into the test surface. The studies performed confirmed that low-energy ion bombardment of a monocrystal

of the alloy  $\text{CoNi}_3$  with its surface oriented parallel to the (100) face results in the enrichment of the said alloy with Co atoms. At close-to-saturation irradiation doses the cobalt concentration approaches 100%. The studies also confirmed that the diffusion of cobalt occurs in accordance with a vacancy mechanism. Low doses of ion irradiation (about  $10^{14}$  ions/ $\text{cm}^2$ ) were found to lead to the formation of two types of point defects in the near-surface layer of the alloy  $\text{CoNi}_3(100)$ : vacancies and Frenkel pairs. Increasing the dose to about  $5 \times 10^{15}$  ions/ $\text{cm}^2$  resulted in the generation of a third type of point defect, i.e., interstitial Ar atoms. The layer-by-layer surface dilatometry proposed and described by the authors further enabled them to establish that vacancies are the main type of radiation defect in the first two layers of the surface of  $\text{CoNi}_3$ , whereas Frenkel pairs are the main defect in deeper-lying layers. The interstitial argon atoms discovered were localized in the first three or four atomic layers. The new layer-by-layer dilatometry technique proposed by the authors was thus demonstrated to permit the determination of types of radiation defects generated and to study their distribution throughout a test specimen's depth. Figures 4; references 37: 11 Russian, 26 Western.

#### The Velocities of Excited Helium Atoms Scattered During the Ion Bombardment of Metals

927M0055H Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 9, Sep 91 (manuscript received 23 Mar 90; after revision 31 May 90) pp 128-131

[Article by Yu.A. Bandurin, L.S. Belykh, A.I. Dashchenko, I.Ye. Mitropolskiy, and S.S. Pop, Uzhgorod State University]

UDC 537.534

[Abstract] The authors of the study reported herein examined the velocities of excited helium atoms scattered during the  $\text{He}^+$  ion bombardment of Be, Al, Si, Ti, Ni, Cu, Mo, Ta, and Pt surfaces. Their primary objective in so doing was to determine the dependence of the likelihood of the excitation of scattered excited particles on their departure velocities within a broad velocity interval. They used the method of measurement of the Doppler contours of the spectral lines radiated by secondary excited particles. The bombardment was performed at angles of  $\alpha = 90, 45, \text{ and } 30^\circ$ , where  $\alpha$  is the gliding angle, i.e., the angle between the plane of the target's surface and the axis of the ion beam. The radiation was observed at an angle of  $90^\circ$  to the direction of the bombardment. The experiments used ion bombardment energies between 8 and 18 keV. Depending on the ion beam's angle of incidence, the current density was varied from 0.2 to 2 mA/ $\text{cm}^2$ . The limiting vacuum in the collision chamber was about  $5 \times 10^{-8}$  torr, and that in the working chamber did not exceed  $8 \times 10^{-7}$  torr. An MDR-2 fast diffraction monochromator was used in the experiments. An automated measuring system based on an Elektronika-100/I computer was used to process the results. The error in determining the absolute value of the wavelengths did not exceed  $\pm 0.01$  nm. The Doppler contour experiments were conducted for an HeI spectral line with a wavelength of 388.865 nm radiated at the



transition  $3p^3P_{0,12}^0 \rightarrow 2s^3S_1$ . The characteristic departure velocities of excited He atoms from the aforesaid metal target surfaces were measured at the three aforesaid angles and recorded in table form. The characteristic velocity of the scattered excited helium atoms was generally found to increase as the atomic number of the target increased. There were a number of exceptions, however, and their interpretation was deferred to future studies. Analysis of the dependence of the position of the maxima of the Doppler contours on bombarding ion energy revealed that as the energy of the oncoming particles increases, the position of the maxima of the Doppler contours of the spectral lines shifts to the short-wave region, thus confirming an increase in the characteristic departure velocities of excited helium atoms. Some degree of broadening of the contours was also noted, thus indicating a corresponding broadening of the energy distributions of the excited scattered helium atoms. The experiment results were found to be in rather good agreement with theoretical Doppler contour computations within the framework of the model of the formation of excited particle states in the competing electron capture and loss processes. Figures 2, table 1; references 6: 5 Russian, 1 Western.

**The Role of the Surface in Processes of Secondary Defect Formation During the Ion Irradiation of Indium Arsenide**

927M0055J Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 9, Sep 91  
(manuscript received 23 Mar 90; 31 Aug 90) pp 154-156

[Article by Yu.A. Danilov and V.P. Lesnikov, Physics Engineering Scientific Research Institute, Nizhegorod State University]

UDC 539.2:539.12.04:621.315.592

[Abstract] The authors of this concise communication examined the role played by surfaces in processes of secondary defect formation during the ion irradiation of indium arsenide. Specifically, they considered selected characteristic features of the kinetics of defect accumulation during ion implantation in n-type InAs monocrystals. They plotted the dose dependences of the absorption factor  $\alpha_b$  of InAs irradiated with  $Ne^+$  ions at a wavelength of 5  $\mu m$ . Ion implantation energies of 40 and 80 keV and doses of  $2 \times 10^3$  and  $2 \times 10^{14}$  ions/cm<sup>2</sup> were studied. The concentration of optically active radiation defects was found to be directly proportional to the value of  $\alpha_b$ . Several different segments were observed in the dose dependences of  $\alpha_b$  for ions of different masses: At first there were one or two segments of a more or less sharp increase in the number of defects as the dose was increased. Then, at some critical ion dose strength  $\Phi_{cr}$ , i.e., when  $\alpha_b$  reaches about  $2 \times 10^4$  ions/cm<sup>2</sup>, a segment of very weak growth in  $\alpha_b$  begins. The results obtained led the authors to offer the following explanation of the mechanism of secondary defect formation: The free surface of InAs serves as an effective drain for the simple vacancy-type radiation defects formed during ion implantation. As defects accumulate to a supercritical concentration, a thin near-surface region undergoes amorphization. Then, when  $\Phi_{cr}$  is reached, the "buried" defect region close to the nuclear loss maximum becomes amorphous. As the dose is increased further, the amorphous regions expand further until they punch through to the depths of the InAs. This phenomenon is similar to the sandwich structure observed previously for Si. The studies performed led the authors to hypothesize that varying the state of a semiconductor's surface (specifically, changing the sign and magnitude of its mechanical stresses by selecting the type and thickness of the dielectric film and the conditions of its deposition) may make it possible to control the process of secondary defect formation during ion implantation. Figures 2; references 7: 5 Russian, 2 Western.



**Delignification of Wood with Oxygen in Acetic Acid Medium**

927M0036A Riga *KHIMIYA DREVISINY in Russian*  
No 2, Mar- Apr 91 (manuscript received  
23 Apr 90) pp 12-16

[Article by N. G. Kostyukovich and I. P. Deyneko, Timber Technology Academy imeni S. M. Kirov, Leningrad]

UDC634.0.861.16:547.292

[Abstract] Environmental pollution problems, associated with traditional cellulose production methods, has stimulated the development of new, ecologically clean, and economical technology. Delignification of wood stock in organic solvents has received much attention recently. However, owing to the severe process conditions, the quality of the desired products is not entirely satisfactory and certain problems are encountered with coniferous wood stock. Molecular oxygen appears ecologically promising as a delignifying agent, were it not for its low solubility in aqueous weak base solutions. Oxygen is much more soluble in organic solvents, which would appear to solve many problems. Recently, it has been demonstrated that oxygen digestion in aqueous acetone and aqueous alcohol gives satisfactory yields of cellulose from wood chips directly, in contrast to the oxygen-base process. In the present work some results are presented on the oxygen delignification of wood in acetic acid at 0.8 MPa pressure and constant temperature. Comparatively high yields of technical grade cellulose having satisfactory properties were obtained with 80 percent acetic acid. A high sugar content in the resulting spent liquor presents the possibility of using these solutions as a substrate for microbiological treatment. Figures 3; references 5: 4 Russian, 1 Western.

**Structure of Various Polymorphous Modifications of Cellulose**

927M0036B Riga *KHIMIYA DREVISINY in Russian*  
No 2, Mar- Apr 91 (manuscript received  
10 Apr 90) pp 35-37

[Article by R. -Kh. N. Mikelsaar and N. Ya. Kuznetsova, Tartu State University; Physical Chemistry Institute, Moscow]

UDC547.458.81

[Abstract] Research using IR-spectra, X-ray diffraction, and NMR-spectra showed that natural cellulose exists in two basic polymorphous modifications, viz. algal-bacterial (IA) and ramie-cotton (IB). Although these modifications have been well studied, a unified concept of their structures and a mechanism for conversion into the mercerized or regenerated (II) form still does not exist. In the present work plastic three-dimensional

atomic models, developed specially at Tartu State University, were used to demonstrate that all three modifications contain anti-parallel molecular models packed in unit cells having different parameters. The proposed concept makes it possible to explain the molecular mechanism for converting cellulose I into cellulose II. Figures 3; references 8: 1 Russian, 7 Western.

**Synthesis and Thermal Decomposition of Hydroxybromobutyl Esters of Cellulose**

927M0036B Riga *KHIMIYA DREVISINY in Russian*  
No 2, Mar- Apr 91 (manuscript received 11 Jun90, after  
revision 4 Jul 90 pp 68-71

[Article by V. A. Klimov, M. A. Tyuganova, and A. F. Sviridov, Chemical Technology Institute imeni D. I. Mendeleev, Moscow; Textile Institute imeni A. N. Kosygin, Moscow]

UDC661.728.89

[Abstract] Cellulose may be made fire-resistant with phosphorus compounds. Since thermal decomposition of cellulose is accompanied by the release of considerable quantities of volatile products, there is special interest in studying its thermal decomposition in the presence of halogens, particularly bromine-containing compounds which are known to inhibit gas-phase processes. In the present work a study was made of the thermo-oxidative decomposition of 2-hydroxy-3,4-dibromobutyl and 2,3-dihydroxy-4-bromobutyl esters of cellulose containing bromine in the aliphatic chain. The latter has been demonstrated to be more effective as a fire-retardant than if present in an aromatic ring. Cellulose esters containing up to 14 percent bromine were prepared by O-alkylation. The fundamental rules governing thermo-oxidative decomposition of hydroxybromobutyl cellulose esters were investigated using thermogravimetric analysis and scanning calorimetry. Figures 2; references 10: 9 Russian, 1 Western.

**Comparative Analysis of Aspen Hydrolysis Subjected to Energy of Accelerated Electrons and  $\text{Co}^{60}$   $\gamma$ -Radiation**

927M0036D Riga *KHIMIYA DREVISINY in Russian*  
No 2, Mar- Apr 91 (manuscript received 12 Jan 90, after  
revision 17 Jul 90) pp 76-80

[Article by V. B. Komarov, S. D. Samuylova, and B. G. Yershov, Physical Chemistry Institute, Moscow]

UDC634.0.813:539.16.04

[Abstract] Radiation of cellulose-containing material increases the susceptibility of polysaccharides to subsequent further treatment, including acid hydrolysis. As the absorbed dosage in vegetable matter is increased, the content of polysaccharides resistant to hydrolysis decreases while the content of readily hydrolyzable

polysaccharides increases, due to polysaccharide breakdown. Irradiation at higher temperatures has also been found to accelerate the breakdown process during pretreatment of vegetable matter. If a high dosage of accelerated electrons is used as a radiation source, conditions could arise for radiation-thermal treatment. In the present work a comparison was made of the effect of  $\text{Co}^{60}$   $\gamma$ -radiation and accelerated electrons on the hydrolysis of wood polysaccharides at radiation doses without application of additional heat. It was demonstrated that irradiation with electrons at doses greater than 9 kGr per second, and an absorbed dosage of over 150 kGr, polysaccharide breakdown is intensified, making the latter more available for hydrolysis. It was further demonstrated that as a result of radiation overheating of material with accelerated electrons, the absorbed dosage needed to convert 50-70 percent of the polysaccharides into a soluble state is only one fourth to one fifth of that required by  $\gamma$ -radiation. Figures 3; references 12: 11 Russian, 1 Western.

**Carbohydrate Determination in Sewage Water and Vegetable Matter Hydrolyzates by High Intensity Liquid Chromatography**

927M0036E Riga KHIMIYA DREVISINY in Russian  
No 2, Mar-Apr 91 (manuscript received 5 Mar 90, after revision 11 Jul 90) pp 81-83

[Article by O. I. Kalchenko and I. M. Starodub, Cellulose Paper Industry SRI (Ukrainian)]

UDC634.0.863:628.54:543.8

[Abstract] Previously developed gas chromatographic methods for the determination of monosaccharides in cellulose hydrolyzates require synthesis of volatile monosaccharide derivatives. Employing liquid chromatography, it is possible to determine monosaccharides directly in aqueous media in much less time and with less probability of carbohydrate breakdown to low molecular weight products, since the analysis is conducted at room temperature. Other techniques, employing mixed solvents such as acetonitrile-water, or water-ethyl acetate-isopropanol, fail to give adequate separation of xylose and arabinose or give results with

overlapping peaks. In the present work a liquid chromatographic technique employing 15-crown-5 ester in the mobile phase was developed for determining carbohydrates in recycled sewage water and hydrolyzates which gives a higher resolution of component separation. The method involves using a high pressure liquid chromatograph, 15cm X 33cm X 3.3mm column, Separon SGX  $\text{NH}_2$  as sorbent, acetonitrile-water-15-crown-5 ester in 83 : 17 : 0.5 ratio by volume as eluent, and a refractometer as detector. Xylose, mannose, glucose, galactose, and arabinose were detected in the samples studied. The method is sensitive to 0.1mg per ml and the relative error is 3-5 percent. Figures 2; references 6: 4 Russian, 2 Western.

**Study of Possibility of Using Spruce Bark as Feedstock for Hydrolysis**

927M0036F Riga KHIMIYA DREVISINY in Russian  
No 2, Mar-Apr 91 (manuscript received 9 Apr 90) pp 84-88

[Article by I. S. Geles, U. Ya. Shmits, Yu. P. Gaylitis, and N. A. Romanova, Forestry Institute, Karelian Affiliate; Wood Chemistry Institute, Riga]

UDC631.571:634.0.864

[Abstract] At the Forestry Institute, Karelian Affiliate USSR Academy of Sciences several methods are being developed for upgrading spruce bark as a possible hydrolysis feedstock to make it more competitive. Specifically, it has been demonstrated that preliminary aqueous extraction, in which some of the tanning components are extracted from the bast fibers of the bark, somewhat improves the biological quality of the hydrolyzate, while utilizing the bast as that portion most rich in carbohydrates, may be considered as upgrading the original feedstock. The amount of aqueous extract leached from the bast varies with the storage conditions. After extraction, the bast was hydrolyzed in two stages. The two hydrolyzates were each treated to lower the content of volatile and colloidal matter, and the biological qualities of the resulting substrates were determined by cultivation of two strains of nutrient yeast. Hydrolyzate from one of the strains was demonstrated to be useful as a source of nutrient protein. References 7 (Russian).

**Kinetics of Acoustic-Chemical Reactions.  
Synthesis of**

**Pentamethylenepentaphenylcyclopentasilane**

927M0021H Moscow *ZHURNAL FIZICHESKOY  
KHIMII in Russian* Vol 65, No 5, May 91 (manuscript  
received 18 Jun 90) pp 1368-1372

[Article by G. P. Los, O. I. Zinovyev, A. A. Savitskiy, I.  
I. Skorokhodov, and M. A. Margulis, Chemistry and  
Technology of Element-Organic Compounds SRI  
(State), Moscow]

UDC669.72.15;622.7

[Abstract] The possibility of accelerating chemical processes as well as controlling chemical reactions by ultra-sound has attracted the attention of many researchers. It has been reported that in the acoustic-chemical synthesis

of dodecamethylcyclohexasilane in tetrahydrofuran, cyclic derivatives are not formed directly, but go through an intermediate polymethylsilane stage. Since the latter are practically insoluble in most known solvents, the kinetics and transformations of these compounds could only be studied by an indirect method. In the present work a study was made of the acoustic-chemical synthesis of the title compound, which forms soluble polymethylphenylsilanes as intermediates. They were prepared by condensation from methylphenylchlorosilane and metallic sodium in toluene at 100° C both in an ultra-sonic field and in its absence. Comparative tests made with gas chromatography and gel impregnation demonstrated that in both cases a mixture of oligomeric polysilanes forms which has both cyclic and linear molecules. Ultra-sound ultimately causes total conversion of linear polysilanes into cyclic analogs. A reaction mechanism is proposed. Figures 5; references 8: 2 Russian, 6 Western.

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